# NATIONAL ANTARCTIC EXPEDITION
1901-1904

# NATURAL HISTORY

## Vol. II.

## ZOOLOGY

(VERTEBRATA: MOLLUSCA: CRUSTACEA)

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# PREFACE.

WHEN, in 1901, the Expedition of the S.S. 'Discovery,' under Captain Scott, R.N., was sent to the Antarctic Regions, the Trustees of the British Museum gave their assistance to this national enterprise by allowing the cases containing the natural history specimens which might be obtained by the Expedition to be sent to the Natural History Museum for unpacking and sorting. They further undertook to publish a detailed report on the collections so obtained, under the superintendence of the Director of the Natural History Departments.

Some of the most important collections have been dealt with by naturalists who were members of the Expedition. Thus, the Mammals and Birds are described by Dr. Edward A. Wilson, the Isopoda and Pycnogonida by Mr. T. V. Hodgson, and the Rocks (in relation to Field Geology) by Mr. H. T. Ferrar. Other groups have been dealt with by members of the staff of the Natural History Departments of the British Museum: Mr. Boulenger describes the Fishes; Mr. E. A. Smith, the Gastropoda, Lamellibranchia, and Brachiopoda; Mr. Jeffrey Bell, the Echinoderma; Dr. Calman, the Crustacea Decapoda, and the Cumacea; Mr. Kirkpatrick, the non-calcareous Sponges; whilst Mr. G. T. Prior has prepared a petrographical description of the Rock-specimens.

It has been necessary to obtain the assistance of other specialists in order to deal with the rest of the collections. So far as the latter group of contributors is concerned, the following is a list of the subject-matters, together with the name of the naturalist who has undertaken the work in each case:—

| | |
|---|---|
| EMBRYOS OF SEALS . . . . . | DR. MARRETT TIMS. |
| ANATOMY OF EMPEROR PENGUIN . . . | MR. W. P. PYCRAFT. |
| TUNICATA . . . . . . . | PROF. HERDMAN. |
| CEPHALODISCUS . . . . . . | DR. RIDEWOOD. |
| CEPHALOPODA . . . . . . | DR. HOYLE. |
| NUDIBRANCHS AND PTEROPODS . . . | SIR CHARLES ELIOT, K.C.M.G. |
| POLYZOA . . . . . . . | MR. H. W. BURROWS. |
| EGGS AND YOUNG OF ASTERIAS . . . | PROF. MACBRIDE. |
| AMPHIPODA . . . . . . | MR. A. O. WALKER. |
| SCHIZOPODA . . . . . . | MR. HOLT. |
| NEBALIÆ . . . . . . . | DR. J. THIELE. |
| OSTRACODA . . . . . . | PROF. BRADY. |
| COPEPODA . . . . . . . | DR. WOLFENDEN. |

| | |
|---|---|
| Cirripedia . . . . . . . | Prof. Gruvel. |
| Myzostoma . . . . . . . | Prof. v. Graff. |
| Acari . . . . . . . . | Dr. Trouessart. |
| Collembola . . . . . . . | Prof. Carpenter. |
| Polychæta . . . . . . . | Prof. Ehlers. |
| Gephyræa . . . . . . . | Mr. A. E. Shipley. |
| Chætognatha . . . . . . . | Dr. Fowler. |
| Nemertines . . . . . . . | Prof. Hubrecht. |
| Free Platyhelminthes . . . . | Mr. F. F. Laidlaw. |
| Cestoda . . . . . . . . | Mr. A. E. Shipley. |
| Nematoda . . . . . . . | Dr. v. Linstow. |
| Zoantharia . . . . . . . | Mr. Clubb. |
| Alcyonaria and Pennatulida . . . | Prof. Hickson. |
| Hydromedusæ . . . . . . . | Mr. E. T. Brown. |
| Calcareous Sponges . . . . . | Mr. Frewen Jenkin. |
| Radiolaria . . . . . . . | Mr. Lewis H. Gough. |
| Mosses . . . . . . . . | M. Jules Cardot. |
| Lichens . . . . . . . . | Mr. Darbishire. |
| Algæ (Marine) . . . . . . . | Mrs. Gepp. |
| Algæ (Fresh-water) . . . . . . | Dr. Fritsch. |
| Algæ (Calcareous) . . . . . . | Dr. Foslie. |
| Phytoplankton . . . . . . . | Dr. Lewis H. Gough. |

The work of securing the assistance of these specialists and of distributing the collections has been performed by Mr. Jeffrey Bell, of the Zoological Department, who has also acted as sub-editor of the Zoological and Botanical portions of the reports. The Keeper of Minerals, Mr. Fletcher, has superintended the reports in the subjects belonging to his department.

The Director desires to acknowledge the ability and energy which have been brought to bear on the preparation of the Zoological reports by Mr. Jeffrey Bell. Owing to his care, the reports have been got ready by the various contributors and published within a reasonable time after the return of the 'Discovery' from the Antarctic Regions. Neither trouble nor expense has been spared in order to render the illustration and presentation of the Natural History of the Expedition worthy of the generous efforts both of Captain Scott and his fellow-explorers and of those who provided the funds for that enterprise.

E. Ray Lankester.

*October*, 1906.

# PREFACE TO VOLUME II.

The chief part of the present volume is Dr. Wilson's beautifully illustrated report on the Birds and Mammals, giving his personal experiences during the Expedition, as well as the results of subsequent study of the collections. This Expedition was the first to discover a nesting colony of the Emperor Penguin.

All the other collections of vertebrates made during the Expedition are here reported on, with the exception of the embryos of seals and the pelagic fishes, which will be dealt with later. The investigation into the development of the feathers of the penguin raises several points of great morphological significance. The collection of fishes is small, but interesting.

The discovery of two new species of *Cephalodiscus*, the presence of which in the collection was first noticed by Prof. Ray Lankester, has been made the basis of an important contribution to our knowledge of the small group to which it belongs.

All the Mollusca collected by the 'Discovery,' except the "Pteropoda," are reported on; the Brachiopoda were but poorly represented. As Dr. Calman's reports on two divisions of Crustacea have been a very long time in type, it was decided to publish them as soon as possible. Several reports have already been printed for the third volume, which will probably appear early next year.

F. Jeffrey Bell.

*December* 3, 1906.

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# INTRODUCTION

TO

# THE REPORT ON MAMMALS AND BIRDS.

THE collection of Mammals and Birds which forms the basis of my Report was made on board the 'Discovery,' and the 'Morning' in the Southern Seas, between 1901 and 1904. For the 'Discovery' collections I am responsible myself; the 'Morning' collections were made by Dr. G. A. Davidson during two voyages of relief to us under Captain Colbeck in 1902 and 1903.

It is not necessary for me to write at length upon the circumstances under which our voyage was made. Its history is to be found in detail in Captain Scott's narrative (The Voyage of the 'Discovery,' 2 vols., London, 1905). What we who were members of the Expedition owe to Sir Clements Markham, and what we owe to all who interested themselves, as he did, in our work and in our welfare, is there told in a way which leaves little for me to add. We agree with every word of it.

But with regard to Captain Scott himself there is a point to be mentioned which finds no place in his book, namely, the untiring interest that he took in the scientific work of those who were placed under his command. Where opportunities must be made and taken at the right moment, it speaks well for the Commander if they are not often missed; and I can say, for my own part, that although a failure to seize opportunities sometimes happened, it was not once due to any lack of sympathy on his part. It is to the interest and goodwill that he showed in all our work that such results as we have been able to collect are very largely due.

But, indeed, there was not one of the naval officers who did not constantly go out of his way to help us by observation, or by practical and often heavy and unpleasant labour; and, if I mention Eng.-Lieut. Skelton as having given me personally the most useful help of all, first as a photographer, and then as a keen sportsman and collector, it does not mean that the others were less generous.

I owe much to Mr. Hodgson, who, in my absence on various sledge journeys voluntarily made it his duty to carry on my work; and to Lieut. Royds, who took a very practical part in the collection of facts and observations.

I am greatly indebted to Mr. Jacob Cross (First Class Petty Officer, R.N.), who made himself acquainted with my work, and gave up much of his spare time to help in it. As a skinner of seals and penguins he had no equal on the ship, and soon surpassed his teacher.

Although the majority of the photographs used in these reports were taken, as I have said, by Lieut. Skelton, I have also used photographs by other members of the Expedition, and for these I express my thanks to them, while I acknowledge their names in the "List of Illustrations." The coloured plates are from drawings by myself, as are the other illustrations in black-and-white, with one exception, namely Plate III. of the Seals, which has been reproduced from drawings by Mr. Engel Terzi.

While acknowledging with real gratitude the time and attention that my proofs have received from Captain G. E. H. Barrett Hamilton, who has looked over the Report upon the Seals, and from Mr. Eagle Clarke and Mr. Pycraft, who have both been good enough to revise the Birds, I must at the same time take full responsibility for the errors and shortcomings that may be found in them.

My sincere thanks are due to Dr. Bowdler Sharpe and Mr. Oldfield Thomas for the facilities given to me while at work in their respective departments, and to Mr. Jeffrey Bell, as General Editor, for much kindly help and many excellent suggestions.

EDWARD A. WILSON.

Westal, Cheltenham.
*January 2nd*, 1907.

# ILLUSTRATIONS

IN

# THE REPORT ON THE MAMMALS.

## COLOURED PLATES.

### Whales.



### Seals.



## FIGURES IN TEXT.

# ILLUSTRATIONS

IN

# THE REPORT ON THE BIRDS.

## COLOURED PLATES.



## FIGURES IN TEXT.

# I. MAMMALIA.

By Edward A. Wilson, M.B.

## CETACEA.

(1 Plate.)

Although there are no land mammals of any kind at present known to exist in the Antarctic, there is an amphibious and marine mammalian fauna in the ice-covered waters of the region, comprising an unexpected number of species, both of Seals and Whales.

In the case of the Whales it would be hard to say how many different species are to be assigned to the Ross Sea alone. But so far as our own observations go, we can differentiate, though we cannot as yet name, at least six or seven that are distinct from one another.

### BALÆNA AUSTRALIS.

*The Southern Right Whale.*

*Balæna australis*, Desmoulins, Dict. Class. d'Hist. Nat., ii. (1822), p. 161; Flower, List Cetacea B. M., (1885), p. 2; Hutton and Drummond, Animals of New Zealand (1904), p. 42.

It seems more than doubtful whether this whale has ever frequented the ice-covered seas of the Antarctic area, but if it has, it is now quite certain that it has either changed its summer haunts from the Ross Sea, where Sir James Ross reported its existence in the forties of the last century, or has become so reduced in numbers as to be practically on the verge of extinction. Many whalers have journeyed in search of this whale to those very seas, and the remarks which are quoted below form the only evidence of its existence there at the present time.

Captain Larsen, in an account of the voyage of the 'Jason,' has given some of his experiences, but beyond saying: "We have had a boat out . . . . in the hope of finding Rethvalen," and "the mate saw three more spouts, and he could only ascertain that one was from a Rethval . . . . but did not see the whale again," he gives no other indication of its existence. He was at the time in about 67° S. lat., 61° W. long. Mr. Bull during his cruise in the 'Antarctic' (1894–5) saw no sign of a Right Whale farther south than the Campbell Islands, though many, he says, were seen in that neighbourhood during May and June, and "plenty" were killed much farther north at the Kermadec Islands during the preceding winter months. On June 29th, off the Campbell Islands, they were seen in pairs and in large schools, but few were seen after this date, and none at the Auckland Islands, where the ship next went. Captain Jensen (1898–1900) too has killed the whale off the Campbell Islands, but has not seen one in

the Southern ice. And lastly, Mr. Bruce and Dr. Donald, who accompanied the 'Dundee Whalers' in 1892, have only to report its total absence.

There has always been much discussion upon the report made by Sir James Ross in 1840, that "Right Whales" were exceedingly abundant in the waters of Ross Sea. But although his report has been fully tested, and much criticism applied to it by various explorers, and although whaling captains have hunted the area in question unsuccessfully, it would nevertheless be wrong to dismiss the report as having been founded upon error, when we consider that it was made by persons who had had more practical opportunities of becoming familiar with the Right Whale than have the majority of naturalists of the present day.

By the "Right Whale" in his report, Sir James Ross certainly meant the *Balæna australis*, a whale which runs as a rule in pairs or singly, and is upwards of 50 to 70 feet in length. Its spout is double, one jet passing to each side upwards and forwards, but neither as high as the spout of the Rorqual. It is said to frequent the seas of the South, where it can find discoloured water of shallow depth. There it has been hunted almost to extermination by a method, the employment of which affords a very sufficient explanation, as it seems to me, of its disappearance. One has but to refer to any account of the South Sea Right Whale fishing industry to learn how first an active look-out was kept upon the bays where this whale was wont to come to calve, and how, secondly, the hunt began with the destruction of the calf, not because it was of value in itself, but because it was known that the mother would then become an easy prey, as she would not leave the bay without her suckling. This is, perhaps, the most complete and rapid method of exterminating an animal that has ever been adopted, and in the case of the Southern Right Whale it seems to have been only too successful.

In the library of the Royal Geographical Society is to be found a short manuscript note by "Whalebone," one of those, I believe, who accompanied the 'Dundee Whalers,' and in it are given a series of rough sketches which indicate methods of identifying the various whales of the Antarctic seas at a distance. In this note it is evident that "Whalebone" was convinced that Ross had mistaken a Rorqual, or a Finner Whale for a Right Whale, and his conclusions appear to be based upon an observation, which we were able to confirm, namely, that the Rorqual shows its fin only some few seconds after finishing its blow. This is a point to which I shall again refer below. The Right Whale, in this manuscript by "Whalebone," is depicted, as usual, with no fin at all, with a double "spout," and a note to the effect that it blows at regular intervals. Sir James Ross may, of course, have been mistaken, but he based his report apparently less on his own experience than on that of some of his crew who had been engaged in whaling cruises, and as this particular whale was at one time abundant in the Southern oceans, breeding freely off the coasts of South Africa, New Zealand, and Australia, there would seem to be no *primâ facie* reason to doubt that at certain seasons of the year it made its way to the Southern ice, as the similar Northern

form makes its way to the ice of the Northern seas in summer. From May to August, we are told, the females of *Balæna australis* visit the Continental coasts to calve. The males are seldom caught, as they rarely approach the land. From October to May, on the other hand, the chief whaling ground lies between the Chatham and Norfolk Islands. It is therefore during the Southern summer months that one may expect to find them wandering southward to the ice; and it was in January, at the height of the Antarctic summer, that Sir James Ross was cruising in these Southern seas. However, the fact remains that, since the days of Sir James Ross, not one of these whales has been quite certainly seen there, and if the Right Whale still visits Ross Sea, it is certain that it no longer does so in anything approaching the numbers that were wont to come. We ourselves, in the 'Discovery,' saw not one.

Mr. Bennett, in his "Narrative of a Whaling Voyage Round the Globe" (1833–36), gives the following details of the species. He says that the barnacles which habitually find a footing on it, incrusting it like rugged rock, do so on account of its sluggish habits in the shallow seas. While at the surface, he says, it spouts regularly every ten or fifteen seconds; the spout is from 6 to 8 feet high, and is emitted obliquely upwards and forwards. At each spout the nose comes high out of the water, and there is no inspiratory drawback as in other whales, the spout terminating abruptly, so that it can be recognised by ear even in the dark. In June and July, he says that pregnant females are to be found in South African bays, and in September mother and calf go out to sea.

## BALÆNOPTERA MUSCULUS.

### *The Rorqual or Finner.*

*Balænoptera musculus*, Linn., Syst. Nat. i. p. 106 (1766); Flower, *op. cit.*, p. 5.
*Physalus australis*, Desmoulins, Dict. Class. d'Hist. Nat., ii. (1822), p. 166; Hector, Trans. Wellington Phil. Soc., 1878, p. 336.

The most striking, perhaps, of all the Antarctic whales both for its abundance, its size, and for the great height of its vertical "spout," is the common Rorqual or Finner, which is said to reach a length of from 70 to 80 feet. It is distinctive also for other reasons.

While the 'Discovery' was cruising in Ross Sea we used to watch this huge whale come to the surface again and again to blow, at intervals of 30 to 40 seconds, and from the fact that at each of four or five appearances no vestige of a dorsal fin was visible, we began to wonder whether we had not found the "Right Whale" that was once reported to be so abundant in Ross Sea. Again and again the "spout" went up into the cold air, a white twelve-foot column of condensed moisture, followed by a smooth broad back, and yet no fin. For some time we remained uncertain as to its identity, till at last in "sounding" for a longer disappearance and a greater depth than usual, the hinder third of the enormous beast appeared above the surface for the first time with its little angular dorsal fin, at once dispelling any doubts we might

have had. We saw a very large number of these whales, sometimes alone, sometimes in pairs, and sometimes in much greater numbers.

On March 2nd and 4th, 1904, when off Cape North and the Balleny Islands, we saw so many together that we could generally count half-a-dozen spouts at once. Many were then in a sportive mood and, in rolling over, showed some yellowish white on the under parts. Some, too, were bellowing, and the noise of the blow was constant, far and near.

There is much variety in the shape of the dorsal "fin" and in the extent to which the back is humped behind it; in Fig. 1 are given a number of outlines which were taken on the spot. The "fin" is always situated far back upon the posterior third of the animal's length. Some, too, have excrescences on the dorsal fin which probably consisted of barnacles, but this we did not observe in the icy seas, where all that we saw were free from anything of the kind.

We saw a pair of these whales in Table Bay on our voyage out; again a pair off the coast of New Zealand, but nowhere did we see them in numbers till we reached the ice. In Ross Sea they were abundant. If, as Sir James Hector suggested, there are really four species of Rorqual in the Southern Hemisphere, they are probably not easily to be distinguished at a distance. I must refer all that we saw to the one species only, though it is possible that they represented also the Southern form of Rorqual which has been given specific distinction under the title *B. australis*, the "Sulphur-Bottom" of Antarctic whalers.

## NEOBALÆNA MARGINATA.

*The Australian Whale.*

*Balæna marginata*, Gray, Zool. Ereb. and Terr., (1846), p. 48.
*Neobalæna marginata*, id., Suppl. Cat. S. and W. (1871), p. 40; Flower, *op. cit.*, p. 4; Hutton and Drummond, Animals of New Zealand (1904), p. 44.

This whale, unless our identification is at fault, is also a common form in the Ross Sea, and is met with constantly wherever there is loose pack ice. It is a black or dark grey whale of from 20 to 30 feet in length, with a very rounded back, and a small hook-like dorsal fin which slopes well backwards. It appeared at the surface almost as it spouted, and as the head went under, the round back rolled up, showing its little dorsal fin, before it disappeared again. (See fig. 2.) As a rule this whale was solitary; occasionally two or three, but never more, were seen together. It was always moving along in an orderly fashion, and never on any occasion disported itself, nor did it ever show more than the back and fin, as I have mentioned.

## AN UNDESCRIBED WHALE.

(See Whales, Plate I.)

Next must be mentioned a whale which Sir James Ross and McCormick have both mentioned as one "of large size, having an extremely long erect back fin," a

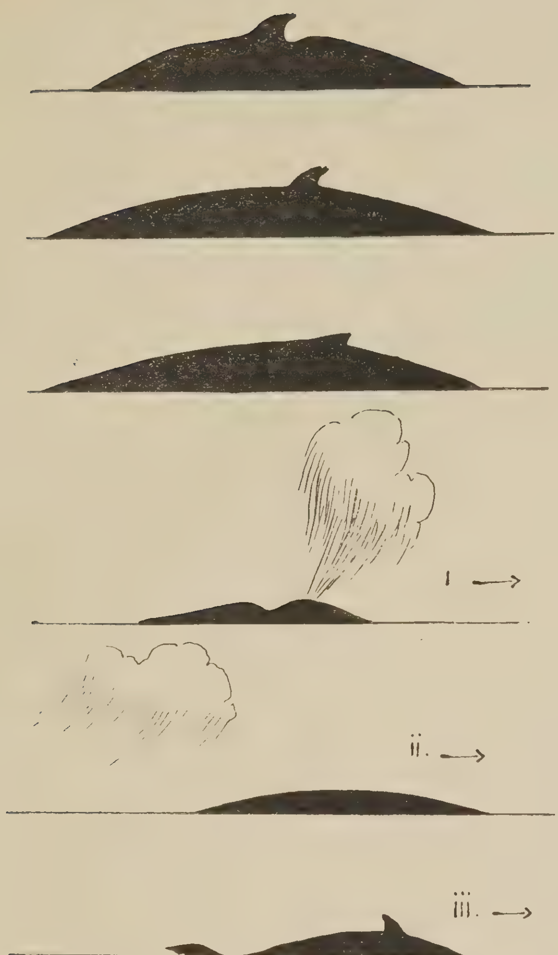


Fig. 1. *Balænoptera musculus*, see p. 3.

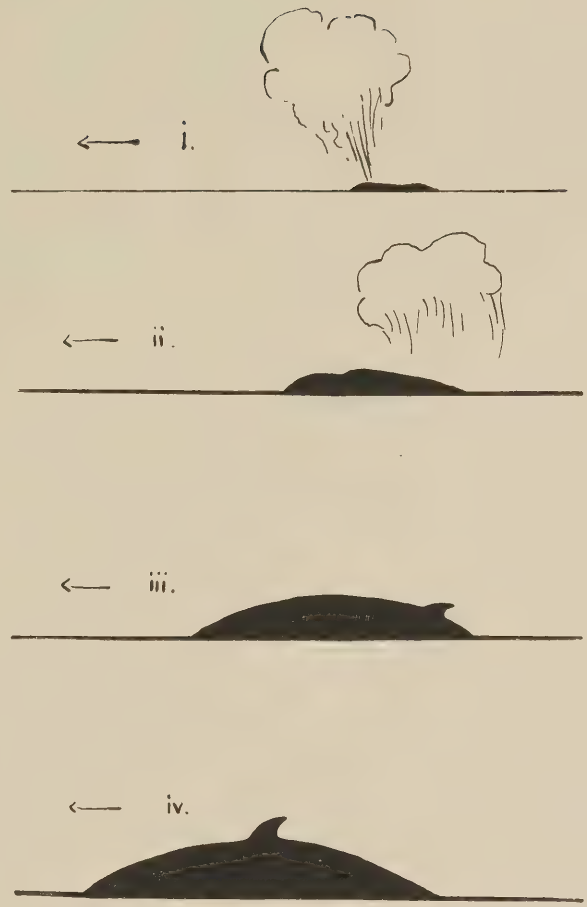


Fig. 2. *Neobalæna marginata*, see p. 4.

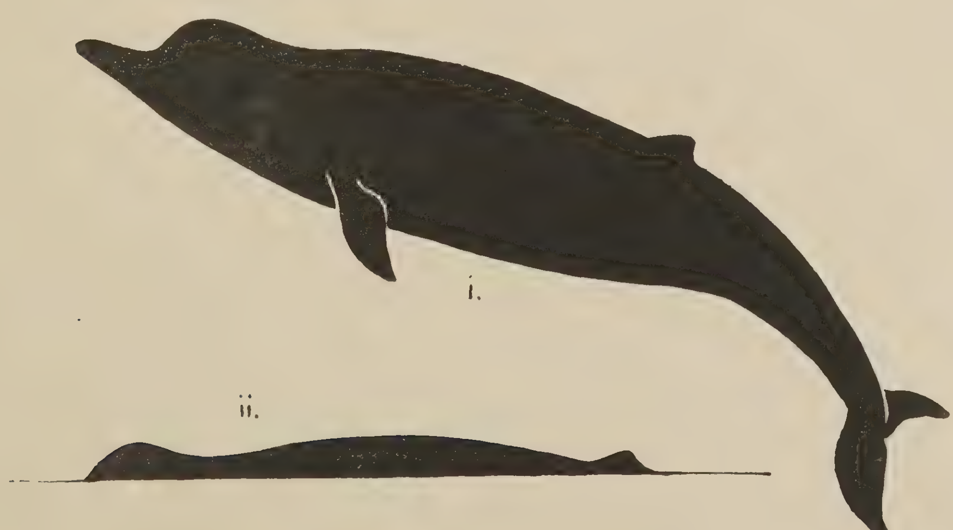


Fig. 3. *Hyperoodon rostratus*, see p. 5.

*To face p. 4.*

description applied to a whale distinct from the *Orca*, which was spoken of always as a "piebald whale," or "a whale marked with white patches."

This high-finned whale, however, of which I am now speaking, is without doubt an otherwise undescribed species, confined perhaps in its distribution to the Antarctic seas. On January 28th, 1902, we saw three together off Ross's Great Ice Barrier, and on February 8th, 1902, again four more of the same kind. They were all of them wholly black above, but had some white about the mouth or chin. In length they were from 20 to 30 feet. But the most striking characteristic about them was the disproportionate height of the dorsal fin, which was erect, pointed, and sabre-shaped, and stood, so far as we were able to judge, from three to four feet high.

In all but one individual this fin curved slightly backwards, but in one the concavity of the curve was towards the head (see Whales, Pl. I., fig. 2a). The "spout" appeared simultaneously with the appearance of the tip of the fin, and the nose, which was square and blunt, came well out of the water immediately after (see Whales, Pl. I., fig. 1). As the head dipped under, the whole back and fin to its base was seen (see Whales, Pl. I., fig. 2). There is no possibility of mistaking this whale for another; the length of the fin is approached only by the *Orca*, whose piebald colour affords an easy means of identification even at a distance. Its movements are also very much more slow and dignified than the rapid racing of a herd of *Orca* whales, and I have no hesitation in declaring it to be a new species of which no example has as yet been taken, though I cannot refer it to any known genus.

## HYPEROODON ROSTRATUS.

*Bottle-nosed Whale.*

*Balæna rostrata*, O. F. Müller, Zool. Dan. Prod. (1776), p. 7.
*Hyperoodon rostratus*, Flower, *op. cit.*, p. 9.

A whale yet remains to be mentioned which I identify nevertheless with much hesitation, as it is impossible to be confident without having had a specimen to examine.

On February 25th, 1902, when the ice had broken back in McMurdo Sound to a point some miles farther South than our winter quarters, we were visited by a small herd of long-snouted black whales which made a great noise in blowing and splashing about at play. There were about six or eight together, and all were in a sportive mood, and one as we were watching "breached," leaping clear of the water, in this way showing himself full length and broadside on against the sky.

The sketch which is given (see fig. 3) was made upon the spot. The animal was some 20 to 30 feet in length, and wholly black above and below. The dorsal fin was a mere excrescence. In shape, the whale was long and slim, with a very prominent forehead and well-marked beak.

Others of a similar kind were reported as "Bottle-nosed Whales" by various officers of the relief ship 'Morning,' and these were seen at the edge of the fast ice in McMurdo Sound during February of 1903 and 1904. It seems, therefore, on the

whole, to be a fairly abundant species in the summer months, frequenting the edges of the ice as it breaks back to its farthest point.

During our voyage out we were accompanied on November 5th (S. lat. 48° and E. long. 100°) by a solitary male of this species, which was of the dull yellow colour that characterises the animal in old age. It measured about 20 feet in length, and was covered with the white hieroglyphic markings which are said to be produced by the arms and suckers of the cephalopods upon which this animal feeds. In this case, as the whale remained with us for upwards of half an hour, and almost rubbed its sides against the ship, we had ample opportunity for observing it closely and satisfying ourselves as to its identification.

It is, however, known mainly as a Northern species which lives, not in the ice, but on its outskirts, and in this, the whales which we identified as *Hyperoodon* agreed, except that they were in the south and not the north. But if the whale is known to exist so far south as S. lat. 48°, there is every reason that it should follow the same instincts in the Southern Hemisphere that it follows in the Northern. It would then go south during the summer, keeping just at the margin of the ice, as we observed it to do in McMurdo Sound, and these facts, taken in conjunction with its occurrence in S. lat. 48°, makes me more certain that this is a species common to both Northern and Southern seas.

It will be seen that the outline given (fig. 3) of the southern form is almost identical, except for a slight difference in the dorsal fin, with that of *Hyperoodon rostratus* as figured in Flower and Lydekker's "Mammals"; but it will also be seen to agree even more precisely with the outline given by Sir James Hector of *Berardius Arnuxii*, *see* pl. xvi, in a paper delivered to the Wellington Philosophical Society, Jan. 12th, 1878.

Whatever, therefore, may be the true identity of this whale, and without a capture it is impossible to say, I give the facts for what they are worth. It is, at any rate, of interest to know that such a whale is to be found in the southernmost waters of the Antarctic; and we may hope that before long some expedition may interest itself in the capture of these doubtful species.

## ORCA GLADIATOR.

### *The Killer.*

*Delphinus orca*, Linn., Syst. Nat. (1766), p. 108.

*Orca gladiator*, Gray, Zool. Ereb. and Terr. (1846), p. 33; Flower, *op. cit.*, p. 18; Hutton & Drummond, Animals of New Zealand (1904), p. 53.

Turning now to the Dolphins, the largest of all, the *Orca*, or Killer, is very abundant, probably the most abundant, of all the Cetacea in the Southern seas. In Ross Sea, and particularly in McMurdo Sound, it was always to be seen—the first to arrive as the ice broke up—hunting along the cracks between the floes, and down the edges of the fast ice, for seals and penguins.

Moving rapidly in large herds, sometimes amounting to a hundred, they were constantly rising to blow in the leads of open water (figs. 4 and 5). In length they were apparently from 15 to 20 feet; in colour, a dirty grey above with a broad yellow-ochre-

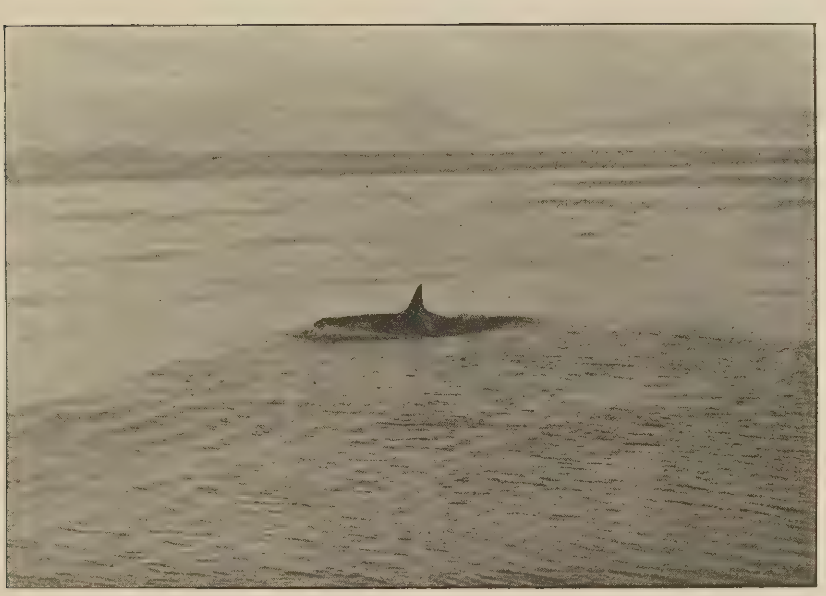

FIG. 4. *Orca gladiator*.

FIG. 5. *Orca gladiator*.

To face p. 6.

coloured saddle on the back behind the dorsal fin ; there was a patch of paler buff behind the eye, and so far as could be seen, the under parts were also pale yellowish white.

Often they followed close in under the ship's stern, disporting themselves like the smallest of the Dolphins; and in a herd that followed our ship on February 17th, 1904, we saw the young ones with their mothers. The young had not yet developed the yellow saddle, but its position was marked out as a dull grey patch in the darker colour of the back. The ear patch, however, was already distinct and of a yellow colour quite conspicuously marked. In the oldest, or at any rate the largest, the saddle is mainly ochreous yellow with an ill-defined anterior border which merges into the grey-black back. The posterior border on the other hand is well-defined. There is much variation in the size and general shape of the dorsal fin in this species, as may be gathered from the sketches given below (fig. 6), which were taken from the animals, as they sported round the ship, in McMurdo Sound.

It is probable that some of these Killers remain always as far south as the periodical opening-up of the sea ice will allow them. They were with us in the autumn to the last days of open water in McMurdo Sound, and were again at once apparent when the ice broke up in the spring. Throughout the open part of the year, from the middle of September to the middle of March, we had schools of this whale in McMurdo Sound; and, no doubt, we could have found them a little farther north in winter as often as the ice in Ross Sea was broken up by the southerly winter gales.

For its diet in the south we have no actual evidence, but, regarding its alleged propensity for seals and penguins, there can be no possible doubt in my opinion that the scars and wounds inflicted on so many of the seals in the pack ice are the marks of wanton, or unsuccessful, attacks made on them by these whales. Such rents are exceedingly common, both as recently inflicted wounds and as mended scars, and the chief sufferers are the *Lobodon* Seals, which live habitually in the pack ice of the open sea, and not Weddell's Seals, which keep to the sheltered bights and bays along the coast-line or the cliffs of great ice barriers. An old *Lobodon* is but rarely to be found without some scars upon his coat; and an idea of the extensive character of some of these wounds may be gathered from the account given below (see p. 39), and from the figure there given, which is taken from scars on one of the skins in our collection. The whole question of the probable causation of these scars being fully discussed in that chapter, I must refer my readers to it, and state here only that I have no doubt whatever in my own mind that the Killer is responsible for them.

Penguins, also, in all probability pay heavy toll to these marauding bands, and from the excessive hurry in which they are often seen to leave the water when a herd of Killers is in sight, it is evident that they know their danger sufficiently well. Moreover, the repugnance they show to re-entering the water, even when chased by men or dogs upon the ice, is an additional proof that they know quite well where their customary danger lies, and that they feel it is safer to tackle an unknown and novel risk on the ice than to face what they know to be a certain danger in the water.

Weddell's Seals are by no means so liberally scarred by the Killer's teeth as are the Crab-eaters, and this results from the fact that they remain almost always some miles on the safer side of the ice-edge, and as far as possible from the open water. Here they are comfortably clear of the Killer Whales, which keep to the breaking edge of the fast ice, and the more or less open water of the pack.

The Killer is heard to blow, and the spout is seen before the snout comes out of the water. They are generally moving at a rapid rate, and, as a rule, the whole head and back and dorsal fin come clear out of the water, after blowing, at every rise. They have the same habit of swimming in close proximity side by side that we have noticed also in the Rorqual. They may be travelling at a very fast rate, yet the pace is so uniform in each individual that they may appear fastened one to the other, each half a length in advance of its companion; constantly appearing and disappearing in this manner they give the idea of a single animal with two dorsal fins, unless indeed they are so close that they can be separately distinguished. I cannot say what is the meaning of this habit either in the Rorqual or the Killer, but perhaps the young and the mother thus find an easy way of avoiding separation whilst making a passage from one district to another.

The range of the *Orca* in the South, as we ourselves observed it, lies between S. lat. 30° in W. long. 30°, where the northernmost examples were found, and S. lat. 78° in E. long. 170° where we saw hundreds at the farthest point of open water to the South. But if, as seems to be the case, the Southern form is identical with the Northern, the range of *Orca gladiator* must be considered universal. That the Southern form is identical with the Northern appears evident from Sir James Hector's mention of two examples which were obtained in New Zealand, the first of which ran ashore in Lyell's Bay, while the second, which he says appears to be a fully adult example of *Orca gladiator*, was cast up on the beach at Wanganui. (Proc. Wellington Phil. Soc. 1880.)

It has been reported also from the Seychelles (4° to 5° S. lat.), from the Cape of Good Hope, from the Northern Pacific, and from the English coast; and if further testimony is wanted as to its ubiquity, it is to be found in Mr. Bennett's words:—"Whales thus designated appeared to us in small bands, and chiefly in the vicinity of the equator." *

## LAGENORHYNCHUS OBSCURUS.

*The Dusky Dolphin.*

*Delphinus obscurus*, Gray, Spic. Zool. (1828), p. 2.
*Lagenorhynchus obscurus*, Blanford, Mamm. Brit. India (1888), p. 580, *ibique citata.*†

We saw the Dusky Dolphin (*Lagenorhynchus obscurus*), a well-known and unmistakable form, day after day playing round the ship in the Southern ocean. We saw also an allied and hitherto unrecognised species of equally characteristic

* Bennett, "Whaling Voyage Round the Globe," 1833 to 1836, ii., p. 239.
† The date of Mr. True's paper is 1889.

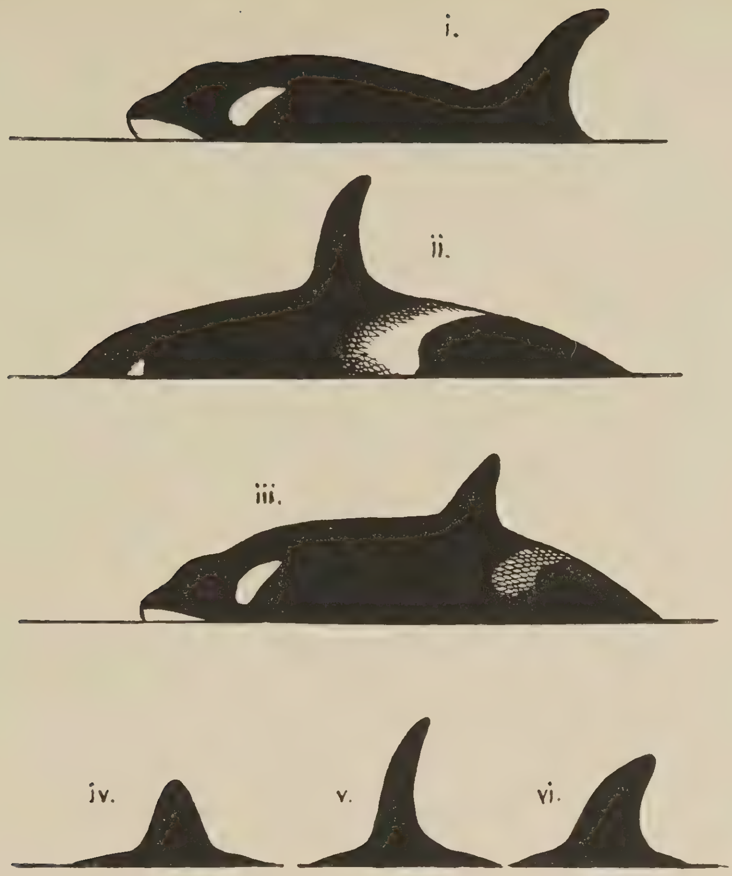

FIG. 6. *Orca gladiator* (*see* p. 6).

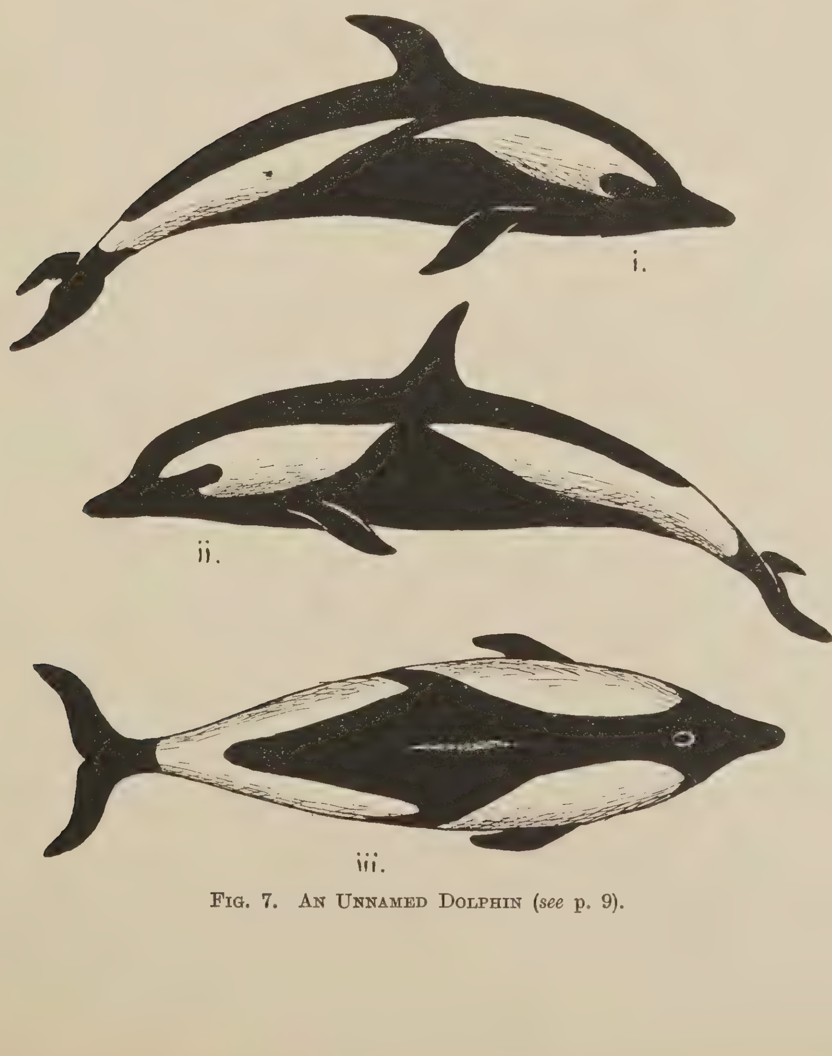

FIG. 7. AN UNNAMED DOLPHIN (*see* p. 9).

*To face p. 8.*

and constant marking, as described below. The distribution of these two Dolphins appears to overlap, and yet, though we had many schools of each from time to time around the ship, they never mingled.

On November 14th and 15th in 1901, when we were between 55° and 60° S. lat. in 135° E. long., we had Dusky Dolphins round us, and were at the same time just outside the ice pack. But a few days later we lost them, and were joined by the other species, which we at once called the Hour-glass Dolphin from the peculiar and characteristic arrangement of its colouring. In this it somewhat resembles that of the Dusky Dolphin, yet is quite easily to be distinguished from it.

## AN UNDESCRIBED DOLPHIN.

This new Dolphin is to be met in abundance in the outer zone of the Antarctic pack ice. We saw it on November 19th in about the same latitude in which we had seen *Lagenorhynchus obscurus* four days before, but farther to the east. We again saw numbers playing round the ship on December 29th, 30th and 31st, and on January 1st, the day before we actually sighted ice on our way to the South in 1902.

Also in 1904, as we made our way to the North, on March 5th and 6th we had large schools of this same Dolphin round the bows of our ship, moving easily with us, though we were running at from 8 to 10 knots an hour. They are from 8 to 10 feet long, and strikingly marked with white and brown. The whole of the back, head, dorsal fin and tail is rich dark brown, as are also the under parts; but there are on each side of the body two extensive patches of white which are separated from one another just below the dorsal fin by an isthmus of the brown which runs obliquely down and forwards, uniting the brown of the upper parts with the brown of the lower parts. In other words, the animal may be described as uniformly dark brown all over save for a broad white lateral band broken in the centre by a bridge of brown, but running otherwise from nose to tail and uniting above the tail. The dorsal fin, which is dark brown, is large in proportion to the size of the animal, and in most cases is falciform, often markedly crooked, almost to a right angle (fig. 7).

Attempts were made with the harpoon to obtain an example of this Dolphin, but without success, and it remains for others to give a more detailed description than is possible at present from observations made only upon animals in active motion.

This short and very insufficient account of the Whales and Dolphins observed during our cruise in Antarctic waters, though it throws little light upon their habits, may nevertheless be of use to some future observer. It is only with the object of pointing out that there are new and unknown species, apparently peculiar to the region, that I have thought it worth while to record our scanty observations. An expedition properly equipped for the capture and study of such animals would assuredly reap a harvest in the South.

# PINNIPEDIA.

(4 Plates.)

## LEPTONYCHOTES WEDDELLI.

*Weddell's Seal, or the False Sea-Leopard.*

(Plates I.–III.)

*Otaria weddellii*, R. P. Lesson, in Férussac's Bull. Sci. Nat., vii. (1826), pp. 437–438.

*Leptonychotes weddelli*, Allen, N. Amer. Pinnip. (1880), p. 467; Barrett Hamilton, Rep. Mamm. 'Southern Cross' Coll., 1902, p. 17, *ibique citata**; K. A. Andersson, Wiss. Ergeb. der Schwed. Südpolar-Exped., Bd. V. 2 (1905), pp. 3–11; Brown, Mossman, and Pirie, Voy. 'Scotia' (1906), pp. 129, 227, 340 *et alia.*

Material in the 'Discovery' Collection.

No. 2, ♂, juv. skin and skull. About three months old. Jan. 23, 1903. McMurdo Sound.
No. 3, ♂, ad. skin and skull. Moulting. Jan. 1902. Ross Sea.
No. 4, ♂, ad. skin and skull. Ready to moult. Jan. 1902. Ross Sea.
No. 13, ♂, ad. skin and skull. Jan. 1902. (*Mounted for B.M. Gallery by Rowland Ward.*) McMurdo Sound.
No. 32, ♀, juv. skin. In first week. Nov. 27, 1902. McMurdo Sound.
No. 33, ♂, skin and skull. Jan. 1902. McMurdo Sound.
No. 34, ♂, skin. McMurdo Sound.
No. 35, ♂, ad. skin and skull. McMurdo Sound.
No. 36, ♂, ad. skin and skull. McMurdo Sound.
No. 38, ♀, ad. skin and skull. Ready to moult. Jan. 1902. McMurdo Sound.
No. 40, ♂, ad. skin and skull. Moulting. Jan. 1903. McMurdo Sound.
No. 41, ♀, ad. skin and skull. Moulting. Jan. 1902. South Victoria Land.
No. 42, ♂, juv. skin and skull. Just born. Nov. 5, 1902. McMurdo Sound.
No. 45, ♂, juv. skin and skull. Seventeen days old. Nov. 14, 1902. McMurdo Sound.
No. 47, ♀, ad. skin and skull. Late summer coat. Jan. 1902. McMurdo Sound.
No. 48, ♂, ad. skin and skull. Beginning to moult. Jan. 1902. South Victoria Land.
No. 49, ♂, ad. skin and skull. Fresh moulted. Feb. 1902. South Victoria Land.
No. 50, ♀, ad. skin and skull. Fresh moulted. Jan. 1902. South Victoria Land.
No. 51, skin and skull. In first year. Ready to moult. Jan. 1902. South Victoria Land.
No. 52, ♂, skin and skull. In first year. Freshly moulted. Jan. 1902. South Victoria Land.
No. 53, ♀, ad. skin and skull. Moulting. South Victoria Land.
No. 54, ad. skin and skull. Moult just begun. Jan. 1902. South Victoria Land.
No. 55, ♀, ad. skin and skull. Moult almost completed. Jan. 1902. South Victoria Land.
No. 56, ♂, ad. skin and skull. Moulting. Jan. 1902. South Victoria Land.
No. 60, ♀, ad. skin and skull. Moulting. Jan. 1902. South Victoria Land.
No. 62, ♂, ad. skin and skull. Weathered pelt. Ready to moult. Jan. 1902. South Victoria Land.
No. 70, ♂, ad. skin and skull. Jan. 1902. Lady Newnes Bay.
No. 71, ♂, skin and skull. One year old. Jan. 1902. Lady Newnes Bay.
No. 72, ♀, skin and skull. One year old. Jan. 1902. Lady Newnes Bay.
No. 73, ♀, skin and skull. One year old. Jan. 1902. Lady Newnes Bay.
No. 74, skin and skull. One year old. Jan. 1902. Lady Newnes Bay.
No. 77, ♀, skull, with aberrant dentition. McMurdo Sound.
No. 78, skull, with much-worn canines and incisors. McMurdo Sound.
No. 80, ♂, skull. McMurdo Sound.
No. 81, ♂, skull. McMurdo Sound.

* Gill is erroneously cited.—F. J. B.

No. 82, ♀, skull, with worn canines and incisors. McMurdo Sound.
No. 84, ♂, very young skull. McMurdo Sound.
No. 85, ♀, skull. McMurdo Sound.
No. 86, ♀, juv. skin and skull. Moulting woolly coat, three weeks old. (*Mounted for B.M. Gallery by Rowland Ward.*) Dec. 23, 1903. McMurdo Sound.

COLLECTION OF EMBRYOS.

Twelve embryos from the earliest stages were preserved in spirit by Mr. T. V. Hodgson.
Two fœtal seals at full term were also preserved in spirit.
This collection has been submitted to Dr. Marrett Tims, of Cambridge, for examination, and will be separately reported.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 16, M. 4. ♂, ad. skin. South Victoria Land.
No. 23, M. 47. ♂, ad. skin and skull. Moulting. South Victoria Land.
No. 24, M. 48. ♀, vix ad. skin and skull. Feb. 1903. McMurdo Sound.
No. 25, M. 44. ♂, vix ad. skin and skull. McMurdo Sound.

HERE and there, scattered far and wide during the summer months in McMurdo Sound, we saw parties of Weddell's Seals lying on the floe. Sometimes one or two only, sometimes ten, twenty, thirty, forty or more lying together, not huddled close to one another, but in scattered parties. The whole frozen strait, from the open water at the mouth to the blind end where the ice of a season or two meets the barrier ice of an unknown number of seasons, the whole of this vast ice sheet is, in fact, one big scattered rookery of Weddell's Seals (*see* fig. 10, p. 14).

On approaching one of the largest collections lying on the floe, it could be seen that, though almost all were sleeping, there was a good deal of lazy restlessness in their slumber. They were not by any means motionless. One or two would be up and moving, loping along in one direction or another for no very apparent reason. Another would be seen coming out of its hole in the ice, clumsily hitching its shapeless bulk up by degrees, wet and shiny, till at last it emerged on to the floe, where it immediately began a rough dry by rolling over and over on the snowy surface. Then it would lope along a little further and settle off to sleep.

We might then walk up to one of the sleepers, and if we approached him up wind no notice would be taken. The eyes are fast closed, and the head is drawn in, wrinkling up the blubber-lined skin in folds around the neck. The breathing goes on as before, a sudden half opening of the nostrils (sometimes in sleep only one is used), a snorting expiration followed at once by a wide opening of the nostrils and a rather less prolonged and noisy inspiration, then the nostrils snap to and remain closed while one can slowly count to twelve or fifteen seconds. No notice whatever is taken of our presence, though we may be only a foot or two from the sleeping Weddell's nose. His eyes remain tight shut, and now he stretches himself and contracts his hind flippers into the most grotesque attitudes; his back itches, and his hand goes round in the most human fashion to scratch it with the long protruding nail of the second finger. Now his hand itches, and with the other he scratches that. Then he yawns, and gurgles in his throat, still always with his eyes tight shut, and he may settle off to sleep

again. You are not a yard from him, and you may shout to him to wake. He takes no notice whatever, so you shout again. He hears you, and, opening his bloodshot eyes upon you, stares in amazement without making an effort to move (*see* figs. 8 and 9, p. 12; also fig. 21, p. 24). He is probably upon his back, but that does not prevent the emptying of his bladder, which, as a rule, is his first move, indicative, perhaps, of some slight uneasiness of mind. This increases as he begins to realise you are something not quite usual, and he slowly rolls over away from your direction, and then stops again to stare and very likely to make a little piping trill in his throat with his mouth shut. It sounds like the tinkling of water in a stone cistern, and you see the movements in his throat.* He is inclined to go to sleep again and forget about you. His large hazel brown eyes no longer show the blood-red canthus as they did before, when you first surprised him, and you walk round to his tail. He objects to this, as a rule, and attempts at once to avoid you by rolling over sideways or slinging his hind quarters round and away from your proximity, his main endeavour being to keep you broadside on. If you insist and manage to touch one of his hind flippers with your foot, he is at once really frightened. He may then either immediately rear half up off the ice at you and bellow with an open mouth, or else he will rapidly roll and shuffle away from you and make off as hard as he can lope for the nearest hole. In so doing he will constantly look round first on one side and then the other to see whether you are following, or else he will make off clumsily with his head held high up in the air, with both eyes widely open, watching you the while along his back, and in this position he forms a very quaint and characteristic picture. Many a time did we wonder at the complete ignorance of danger exhibited by this seal, so wholly different to the suspicious character of its kindred in the North.

Their rookeries were a constant source of interest to us and an ample food supply, from which we drew largely for our needs. The meat was coarse in fibre and very dark, but by no means rank, and although the blubber was uneatable the flesh was our greatest stand-by, not only as a preventive of scurvy but a certain cure for the disease.

Judging from our experience in passing first through the pack ice north of Ross Sea, and then along the coast of South Victoria Land, Weddell's Seal is to be found only within sight of land or of land ice. We saw no example of it in the pack ice, and in this respect confirmed the late Mr. Hanson's observations on the 'Southern Cross' Expedition. There can be no doubt now that Weddell's Seal is definitely a coastal species, which never wanders farther from land than it can help, though occasionally it is carried by drifting ice to various distant islands, and even across large stretches of sea and open ocean to lands where it can only be considered an accidental visitor. For example, it has been reported from Juan Fernandez, Kerguelen and Heard Islands, and even from New Zealand, where a specimen was stranded on the

* Weddell's Seal when quite young gives a "baah" like a sheep. This becomes a roar as the seal grows older, but other and more musical notes are common, such as a moan beginning with a high pitched note and ending with a low one, often like an ice moan; or a series of plaintive piping notes may be produced, ending on the call note of a bullfinch, or changing to a long shrill whistle which terminates with a grunt or a snort or a gurgle.

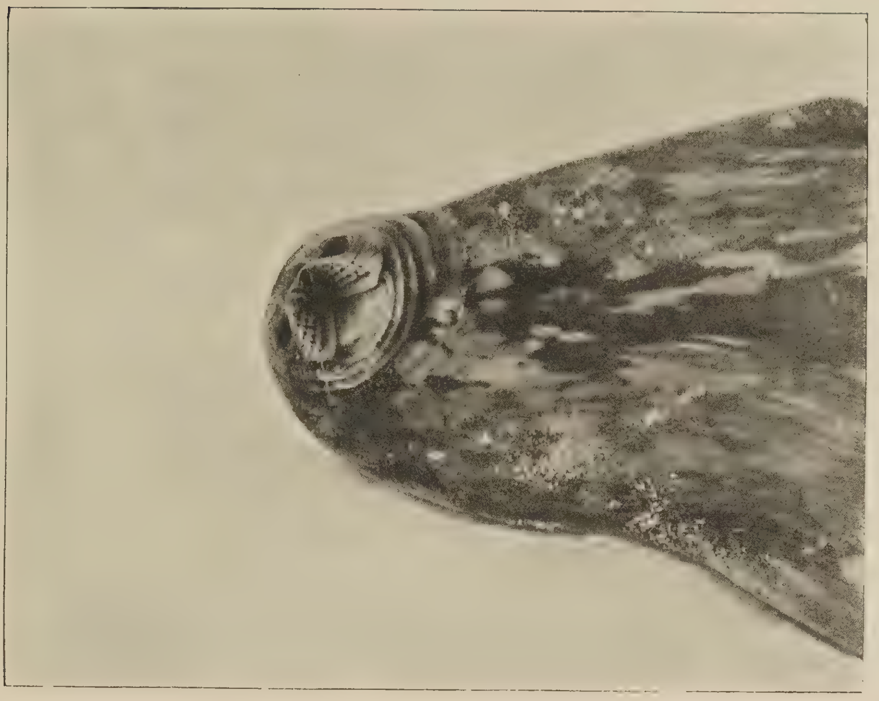

Fig. 8. Weddell's Seal, adult ♀.

Fig. 9. Weddell's Seal, adult ♀.

To face p. 12.

beach outside the Heads and was deposited in a museum at Wanganui. The first specimens placed in the British Museum were procured from the river Santa Cruz on the East coast of Patagonia. Sir James Ross procured but one specimen from the Antarctic. Kerguelen and Heard Islands seem to be more frequently visited by wandering examples of *Leptonychotes* than the more Northern lands as one would expect, and Mr. Moseley reported a herd of four hundred of these seals on an outlying island of Kerguelen, and many bones of the "Sea Leopard" on Heard Island. Whether these were really *Leptonychotes* or *Stenorhinchus* is still doubtful, and judging only from probabilities one would be inclined to think that they were at any rate not Weddell's Seals. It is certain, however, that one true example of *Leptonychotes* was taken at Kerguelen.

By the "Belgica" Expedition Weddell's Seal was seen abundantly in the Palmer Archipelago, and by the "Southern Cross," and the "Antarctic" (Bull's cruise) all along the coast of South Victoria Land. Dr. Donald and Mr. Bruce in the Dundee Whalers' cruise saw a few of this species in Graham's Land, and more recently they have been reported as "very numerous" in the South Orkneys, where "over a hundred could often be counted lying on the small raised beach on the west side of Scotia Bay." In the Weddell Sea it is reported by Dr. Pirie and Mr. Brown to have been seen off Coats' Land, 74° S. and 22° W., in March, and again by Dr. Nordenskjold to have been the commonest of all seals in Louis Philippe Land, where, however, he adds, "it could not be depended on during the winter months;" and finally it was met with by the German Expedition off Kaiser Wilhelm's Land; while in Adélie Land, it is noted in Wilkes' and Dumont D'Urville's narratives under various names, and the "Sea Elephant" so constantly mentioned by Wilkes, refers in all probability very often to Weddell's Seal.

The normal range of distribution of *Leptonychotes* is therefore more or less coincident with the coast line of Antarctic lands and not with the distribution of the Antarctic pack ice. Occasional examples may be carried by drifting bergs to the northern limit of ice in the winter months, but as Weddell's Seal is not in any complete sense a migrant, it will not be less rare in these latitudes in the winter than in the summer. The Southern limit of its range is the same for summer and winter, and coincides with the limits of Barrier ice and the coast-line of the so-called Antarctic Continent.

Weddell's Seal does not migrate. It is to be found at the southernmost limit of its range throughout the winter months, but is not so much in evidence at that season as it is in the summer months. Its southernmost limit throughout the year is decided by the possibility of obtaining food, and not at all by temperature or climate, neither of which seems to affect either it or its supply of food to any considerable extent. The food of Weddell's Seal consists almost entirely of fish, though the beaks of cuttle-fish are often found in the stomach, showing that its diet is not exclusive. Crustaceans also form a small part of its food supply, and, as in most other

seals, there is always a large quantity of mud, sand, and stones in the stomach, which appear also in the excreta. This mud is introduced, no doubt, largely by accident in collecting the fish and crustaceans which inhabit the bottom of the shallow seas.

Some of our seamen during the winter months would wait at the seals' blow-holes with a harpoon and line, and with these even the largest Weddell's Seals could be transfixed and landed. As they had often been feeding immediately before their capture, it was possible sometimes to take ten or twelve little-damaged fish from the stomach before digestion had commenced. The fish commonly obtained were species of *Trematomus*, *Notothenia*, and *Gymnodraco*. These seem to be as plentiful in the winter as they are in the summer months, the actual temperature of the sea-water varying but slightly throughout the year. The mere fact that the sea is frozen at the surface does not make much difference to the marine inhabitants. The average temperature of the water in the winter months from April to September is just above the freezing point of sea-water. Consequently there is a uniformity of temperature under water during the winter, which is by no means to be found in the air. This not only allows marine life to continue and flourish throughout the year, but it also accounts for the non-migration of Weddell's Seal, and for the fact that, although it is almost as abundant as in the summer in point of numbers, it is not by any means so much in evidence. These seals, which may be seen during the summer lying in hundreds on the fast ice, live during the winter almost entirely in the water. They find it far more comfortable to remain in water at a uniform temperature of 28° F. than to expose themselves to temperatures ranging from about zero to − 50° or − 60° F. in the air, where wind and snowdrift would make their existence infinitely less comfortable even if the temperature itself was less severe. Therefore, apart altogether from the fact that the winter months are dark and prevent seals from being seen at any distance, there is no doubt that they really leave the water very little and only when there is no wind and a moderate degree of cold, conditions not often occurring together at the latitude of our winter quarters. Nevertheless, we are certain that they were still with us in the depth of the winter, not only because the blow-holes were always found open, but because we could hear their signals to one another underneath the ice, and because we could actually bring them out at the end of a harpoon line whenever we cared to wait for them at a blow-hole.

Throughout the two winters spent in McMurdo Sound, in lat. 77° 50′, the farthest point South at which they have yet been recorded at any time of the year, we noted every occurrence of a seal on the ice out of the water. Quite a large number were seen and many more heard during the first winter, when the ice was constantly breaking up in the strait to within a few miles of the ship, even so late as May 5th, and though fewer were seen in the second winter, when the open water was never nearer the ship than 10 or 12 miles, there was still a considerable number with us. Consequently we knew that the movements of the greater number were influenced by the proximity of open water, but not to the extent of more than a mile or two, and

Fig. 10. A Rookery of Weddell's Seals.

Fig. 11. Weddell's Seal at its Blow-hole.

To face p. 14.

certainly not to anything approaching what might be called a seasonal migration. Weddell's Seal is therefore not a migrant, and that it is less abundant in the winter months than in the summer is rather the result of a change in its habits, than of any radical change in its local distribution.

This is an interesting point in the history of Weddell's Seal, for it marks it off as the species which has adapted itself more perfectly to Antarctic conditions than any of the other Southern forms, and it has a bearing also on its comparative immunity from the attacks of Killer Whales, as will presently be shown.

The Killer Whales throughout the year remain quite as far South as the periodical break up of the sea ice will allow. They are to be seen the last thing in the autumnal twilight (March 7th and 9th in 1902) and the first thing in the spring (September 14th in 1902) hunting in herds along the edges of the fast ice, as the floes break off and drift away.

If, then, Weddell's Seal lived actually at the limiting edges of the fast ice, and was wholly dependent upon the proximity of open water, it would be no more immune from the attacks of the Killer Whale than are the Crab-eater (*Lobodon*) and Ross' (*Ommatophoca*) Seals, but it is not so dependent upon open water, for it retires as this advances in the summer months, betaking itself to the fast ice which is still unbroken in the sheltered bights and bays along the coast-line.

If, on the other hand, it wanders from the actual shores and sheltered bay ice of the coast, it is not to tempt fate in the pack ice, but to take advantage of the peculiarities in the formation of the Ice Barriers which ring round the Antarctic continent, where, diving deep under the frowning ice-cliffs that confront the open water, and coming up a quarter of a mile or more from the actual edge, it reaches the Barrier surface where it dips in a valley to the water-level. Nothing could be more surprising, after first scaling the ice-cliffs to reach the snowy surface of Ross' Great Ice Barrier, for example, than to find that the surface gradually dips again into a long valley filled with seals and seal-holes at the level of the water.

Weddell's Seal in this way has gone farther than any other species to outwit its enemies and find seclusion without reducing its chances of securing food. In the summer, where it basks on the fast ice it is absolutely safe, and where it breeds it is even more so. Where it feeds it is sometimes open to attack, but by no means always, since it finds food freely in the water beneath the ice on which it basks and breeds. In the winter, knowing that open water means danger, it is safe when the sea is frozen, and by retiring South as storms break up the sea ice, it is safe while the sea is being opened up.

That its security is not merely theoretical is strongly evidenced by the almost total absence of all scars in the skins of the 'Discovery's' collection. Nor are these skins exceptional, for it is a very rare thing indeed to find a Weddell's Seal with such scars and ugly wounds as are to be found commonly on the large majority of Crab-eaters' (*Lobodon*) skins. I have only on one or two occasions seen scars such

as might have resulted from the attack of a Killer Whale, on Weddell's Seal. Some no doubt fall victims to these voracious animals on the coast and at the edges of the unbroken ice, and probably if attacked at all they would have a smaller chance of escaping with wounds only than would the more agile *Lobodon* or *Stenorhinchus*. Some, too, no doubt, get carried off to sea on drifting floes from time to time while sleeping and fall a prey to the Killers in making their way back to shore, but the account I have given above applies to the great majority, and it is in them that habit is adapting itself to circumstances in a way not yet appreciated by the other species.

I have mentioned that Weddell's Seal during the winter months spends most of its time in the water beneath the ice. We arrived at this fact in various ways. They were rarely found on the ice in the neighbourhood of their blow-holes or of the tide cracks, yet they kept these blow-holes open, and could be harpooned as they came up to breathe, all through the winter months. In addition to this we had other evidence. Our ears, for instance, convinced us that seals were with us in considerable numbers, though they so rarely showed themselves. Again and again while sitting up at night as meteorological observers, in the silence which reigned when others were asleep, we would hear the gurgling, bubbling, guttural notes of Weddell's Seal beneath the ship, sounds which we knew so well from having often watched the seals as they made them. There was no mistaking them, nor did anyone fail to hear them, and they were not to be confounded in the dead stillness of the night with the contraction of the rigging or the movements of the ice or ship. Sometimes one would hear definite thuds beneath the ship, the seals bumping against the timbers as we had often heard them bump against the ice. At other times, and almost at any time out on the sea-ice, if we stooped to listen with an ear to the floe, we could hear the guttural notes of the seal, or its bubbling trill, or the thud of a seal's head given, we imagined, by way of signal to its fellows. All these noises were carried by the ice to considerable distances, and, as it seemed, formed a simple system of communication between seal and seal through the medium of the solid ice. Sometimes also, as we walked along a frozen crack, we would be arrested by the scrunching noise of seals' teeth opening up new ice in the crack to form a blow-hole.

As early spring approached, and we began to go farther afield during the short hours of approaching day, we realised that more seals were leaving the water to bask in the scanty sunlight. If then we followed one of the scars formed across the strait by the re-freezing of a crack, we would find a series of blow-holes and holes for egress and ingress averaging 180 yards apart. About every third hole would be enlarged to allow a seal to leave or enter the water, and round these there was abundant evidence of occupation during the winter months, even if no seal was actually lying there when we approached.

To give an example of one of these refrozen cracks, on June 18th we made a list of all the seal holes discoverable in a scar that ran for some miles to the

Fig. 12. Weddell's Seal and Young, just born.

Fig. 13. Weddell's Seal and Young.

To face p. 16.

westward across McMurdo Sound. The distance in yards is given between the holes :—

| | | | |
|---|---|---|---|
| Hole No. 1 | ... | ... | For egress and ingress. |
| 400 yards to No. 2 | ... | ... | Blow-hole only. |
| 140 yards to No. 3 | ... | ... | Blow-hole only. |
| 200 yards to No. 4 | ... | ... | For egress and ingress, 1 ♂ seal out. |
| 140 yards to No. 5 | ... | ... | For egress and ingress, many signs of occupation. |
| 60 yards to No. 6 | ... | ... | Blow-hole only. |
| 150 yards to No. 7 | ... | ... | Blow-hole only. |
| 180 yards to No. 8 | ... | ... | For egress and ingress, 1 ♂ seal out. |

The depth of water beneath these holes was about 300 fathoms. By such signs as the above, and without actually seeing by any means so large a number of seals as in the summer, we gradually convinced ourselves that there were, nevertheless, a large number upon the spot. Nor were those that we saw or caught of any one age or sex. Some were males and just as many were females ; some were yearlings, but many more, as one would expect, were adults. All were very fat, and their coats in excellent condition ; perhaps the fattest of all, at any period of the year, were the adult females that we met with in the spring. The huge animals used to collect in various secluded spots, often many miles from open water, as for example at Pram Point to the south of Cape Armitage, where from twenty to twenty-five miles of solid ice separated them from the nearest open sea. There they lay, entering the water from time to time by holes or cracks amongst the pressure ridges, throughout September and October, waiting for the birth of their young. These began to appear first on October 22nd in 1902, and on October 25th in 1903, at the Pram Point rookery, which was not only the largest but the nearest of all that we met with in McMurdo Sound. If we wandered northwards, along the west coast of Ross Island, we could find here and there, along the tide crack, a group of breeding Weddells. Further still, if we came to Tortoise Rock we found again mothers and young amongst all the pressure ridges around that island, and by the tongue of a glacier, or away amongst the Delbridge Islands, again large numbers of old and young, but nowhere were they so plentiful or so convenient for observation as amongst the ridges of broken ice about Pram Point. This nursery was visited every day or two as the state of the weather allowed ; and here, on returning from a sledge journey in 1903, I found that Hodgson had generously "ear-marked" every infant as it was born by attaching a tin label with a number to its hinder flipper, much against the infant's will and often enough with scanty approval from its parent. By means of these labels we were to some extent able to watch the changes in the coat of the infants during the first month of their existence (*see* figs. 12 and 13, p. 16 ; also figs. 14 and 15, p. 18).

At birth the young Weddell's Seal is clothed in a woolly coat of long hair, of a rusty greyish colour, presenting but the faintest indication of any marking (*see* figs. 16 and 17, p. 20). This woolly coat consists of two varieties of hair, the one 2·8 cm. long, fine, and almost straight; the other shorter, fine, and very curly, so

curly, indeed, that in a hair of 1·7 cm. in length there are no less than eight or ten curves or bends. It is worn for the first fortnight, though at the end of this period it has a less woolly appearance and the hair seems shorter. There is also a suggestion of light spots on the sides and darker marks and splashes beneath as in the adult animal. The change in the character of the coat is due more to the fact of the animal's rapid growth at this time (from 57 inches at birth to 72 inches at the end of a fortnight), than to any actual change in the woolly covering itself; though it is possible that some of the curly hairs begin to drop out earlier than the straight. At the end of a fortnight, however, a regular moult begins (*see* fig. 19, p. 22), and observing as strict an order as in the adult, the wool is first shed from the head and flippers, both fore and hind simultaneously; then running along the mid-line of the back it spreads down the sides and eventually clears the chest and belly. This process occupies a fortnight, so that by the end of the first month of its life the young seal has shed the coat it was born in, and has assumed a very rich and handsomely marked coat of thick, straight, and short hair, thus becoming an exact copy in miniature of the most handsomely marked adults, while measuring between 6 and 7 feet from nose to tail instead of about 9 feet (*see* fig. 20, p. 24).

Up to this stage the infant has been wholly dependent upon its mother for sustenance, and the mother leaving her offspring on the ice has regularly entered the water to supply herself with food. The young seal thus left to itself either sleeps in the sun or crawls under the shelter of a neighbouring hummock. Many of them at this stage succumb to the cold, and it is by no means an uncommon thing to find them dead a day or two after their birth. Their eyes are open at birth, and the involution of the umbilical cord takes several days. The young seal is found at times with the cord intact, attached to the expelled placenta. Presumably the cord is bitten through by the mother, though we did not see this done. The placenta with its membranes is soon demolished by the Skua gulls, which attend in numbers, but it did not appear to strike them that the young seals would form an easy prey. In no case did we see even a dead young seal attacked. Probably the skin proves a difficulty, though the blubber beneath when exposed by ourselves in a skinned seal was very rapidly stripped by these birds. Occasionally we would skin a seal and leave it on the floe to be flenced by Skuas; and though it was never completely cleaned, the total weight of the skin, which might have to be dragged for some miles upon a sledge to reach the ship, was much reduced.

Weddell's Seal suckles her young, and in no case did we see more than one young one born to any seal, upon the ice. Lying upon her side she exposes two nipples in the abdominal region (see Seals, Plate I.), which, though hardly visible when not in use, are erectile organs which become prominent when the young is sucking. The milk is white and creamy and the glands flat and extensive beneath the skin, showing no prominence from without. Not more than two glands and two nipples are developed.

The mother seemed to be much attached to her infant, and in some cases would attack us viciously if we attempted to interfere with it. In others she was

Fig. 14. Weddell's Seal and Young.

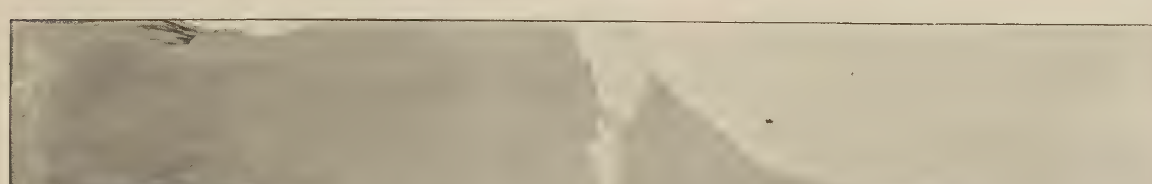

Fig. 15. Weddell's Seal, Suckling its Young.

To face p. 18.

absolutely callous both to the struggles and the bleating cries of her young, with which we were struggling in our efforts to attach a label to its tail. In the absence of the mother the young one would occasionally make its way to a neighbouring seal, and, if she happened to have a young one too, one might be misled into thinking that she had given birth to the two herself. Quite probably this happens sometimes, but we were never quite sure of such a case.

At the end of a month, when the young one has moulted its woolly coat and has donned its richly marked coat of hair, it is taught by the mother to enter and leave the water, she the while giving her assistance by pushing from behind; soon, no doubt, the young seal begins to supply itself to some extent with food. Even after it has learned to enter the water, however, it can often be seen to take milk from its mother, but on December 23rd the stomach of one that was killed contained only fish and isopods. Lactation, therefore, cannot long continue, and probably as a rule the young one becomes wholly independent within six weeks of its birth oı a week or two after entering the water.

At the end of its first year the young seal is still easily recognisable as a yearling by its small size. Thus at the end of its first winter it reached about two-thirds of the size of the normal adult, and measured between 6 and 7 feet from nose to tail. During the following winter, however, the discrepancy ends, and before two years of its life are out the Weddell's Seal arrives at adolescence. Whether it then breeds or not it is impossible to say; but, judging from the damaged condition in which one finds many adult males, and even very old ones, from the severe fights which take place in the third week of October and in November and December, I am inclined to think that few males can breed until at least their third or fourth years. The gestation period in the female is as nearly as possible eleven months. One may find during the above-mentioned months old males in secluded spots literally covered with open wounds from head to tail. All these wounds are short and comparatively shallow, and most abundant about the head, neck, and genital orifice. The last appears to be the main object of attack in all their battles, and in the majority of cases the region is in a terribly torn condition (see Skins No. 3 and No. 48 in the 'Discovery' Collection). Neither do the wounds heal with any great rapidity, suppurating sores remaining often for many months. But the wounds received and given by the males in their contests during the rutting season must not be confounded with the far more serious wounds found on males and females alike, though very rarely in Weddell's Seal, as the result of attacks made on them by the Killer Whale.

The seal's teeth produce multitudinous wounds, it is true, but none are more than a few inches in length and these seldom deeper than the skin; the Killer's teeth, on the contrary, produce the most serious rents, often from 12 to 20 inches in length, limited in number, from two to six in parallel rows about two inches and a half apart from one another; these will often be deeply cut through skin and blubber right into the very flesh, and mainly upon the ventral surface.

At the close of the rutting season, which follows directly upon the separation of the young ones from their mothers, it is noticeable how often one may find the bulls in secluded places, to which they have retired with a multitude of open wounds. This bears upon the discovery of dead seals, not only in secluded spots, but in places which one would have thought were almost inaccessible to them. There can be no doubt, however, that the same instinct which leads a temporarily damaged bull to retire from all company for awhile leads a sick or aged seal which no longer feels equal to the struggle for existence amongst its fellows to retire still further, and to persist in its efforts at retiring to the moment of its death. In this way, and in no other, can we account for the discovery of dead seals at a distance of 35 miles inland from the coast, and on the surface of a glacier no less than 3,000 feet above sea-level. In these cases the carcases were those of Crab-eaters; again the carcases of four Crab-eaters were found by Mr. Ferrar at the foot of "Cathedral Rocks," in the Royal Society's Range, 2,000 feet above sea-level, and thirty miles inland. Yet another was found on New Harbour Glacier, 200 feet above sea-level, and twenty miles from the coast.

The carcase of a Weddell's Seal was found by Lieutenant Armitage 2,400 feet above sea-level on a similar glacier, and other seal remains at similar heights and distances from the coast. On another sledge journey along the western side of McMurdo Sound two dead Weddell's Seals were found, much weathered, on the tongue of Koettlitz Glacier, some twenty miles from the sea-ice; and, still further in, an old and battle-scarred male alive, and covered with suppurating sores, more than twenty miles from any of his kind. The instinct of retirement is strong when evil overtakes these animals, and their one idea is to get far away from their fellows. Starvation in such cases must have expedited matters, and the climate being of a kind to preserve the remains, we came upon them, as I have stated, in the course of our various sledge journeys.

Weddell's Seal, by its shape and build, is by no means so well fitted for progression on the ice as it is for rapid movement in the water. All its enemies—they cannot be very numerous—are in the water; its food also is in the water, and its whole energies must be directed to the avoidance of the one and the overtaking of the other. It therefore becomes transformed on entering the water into a rapid fish-like swimmer that can beat the pace of the fishes that form its food.

If one watches this seal on a flat surface (and when out of the water it is almost always on sea ice), one notices that the ordinary method of progression is a very laboured "hitching along" of its bulky body a foot or two at a time, the chest being used as a fixed point upon which to draw up the remainder of the body by the action of the abdominal muscles. In this way the pubic part of the pelvis becomes in turn the fixed point, and upon it the body is again shot forward. The limbs in this mode of progression are not brought into action at all, indeed the hind limbs, palm to palm, are held in a vertical plane extended backwards with the tail and raised from contact with the ice. The fore limbs, also held closely applied to the sides of the chest, cannot even be considered of use in keeping the animal on an even keel, for

FIG. 16. YOUNG WEDDELL'S SEAL, JUST BORN.

FIG. 17. YOUNG WEDDELL'S SEAL, JUST BORN.

*To face p. 20.*

when the trail of a seal on the snow is examined there may or may not be, on one side or the other, a mark showing where one fore flipper did actually but quite accidentally touch the snow. Under all ordinary conditions, therefore, it is seen that this seal has quite given up the use of its limbs on land or ice, a point in which it differs from several of the other true earless seals, and a point which suggests that a very long period must have elapsed since it enjoyed the power of using its limbs as an ordinary quadruped.

I mention below, in connection with *Lobodon*, that the extremity of fear will revive a method of more rapid progression which closely resembles the canter of a four-legged animal; but this re-awakening of a power that must have long lain dormant was never once noticed in the case of *Leptonychotes*. I do not think that the limbs in *Leptonychotes* were ever seen to be called into play in accelerating the rate of movement, nor was any other method of progression noticed than the hitching, loping, or "looper caterpillar" method of which I have already spoken, a method that reminded one of nothing so much as the progress of the caterpillar of one of the Geometer moths. If pressed to exert itself, this method of progression was not changed, though the movements became very flustered, and then it was a common thing to see the head held high in the air that the pursuer might be kept in sight, the seal watching him with wide open eyes along its back and shoulders, instead of turning its head sideways, first one way and then the other, as is usually the case when the animal is less seriously frightened.

In the ordinary course of events it required a considerable amount of interference to disturb the equanimity of a Weddell's Seal. Having no enemies outside the water, it gazes with blank amazement upon man and dog, with difficulty realising that either can have the power to hurt. There was always, however, some risk of its swinging round to bite, and this the dogs soon learned; for the bite of a full-grown seal was by all means to be avoided; the seal's movement in this respect is very quick, and the grip being followed by a wrench would certainly tear the flesh from the bones.

Above all else this seal is an adept at rolling sideways out of reach from danger, but in doing so it is merely following the instinct which forbids it to expose its more defenceless extremity towards the enemy. There seems to be no need for it to practise any but the most labour-saving methods of movement out of the water. Having no enemy on the ice when man and his dogs are absent, its needs for travel at the worst of times are not exacting. It lives within reach of some permanent crack or opening in the floe, which may be either a tide crack along the shore, an opening which never fails, or a line of weakness running out for miles from some cape or headland. Occasionally, in ice many seasons old, one may find a blow-hole domed over by the frozen breath, as in fig. 25, p. 38; and this may be still in use, though the ice be five or six feet through. Only on a very few occasions have we seen a track prolonged for any distance in the snow. In one exceptional case a track, made by a seal which had apparently lost its way, led fairly straight for about half a mile from one area of pressure ridges across a bay of unbroken ice to another area off a small headland, where

open cracks were always to be found. During blizzards and heavy weather these cracks get completely hidden up in snowdrift, and one may see that the seals experience a certain amount of difficulty in finding them again, if they happen to have been lying out while the storm proceeded. In this case one finds them burrowing into the snow with their noses, and when they discover the crack, in all probability by this time half frozen up and filled with snowdrift, they commence with their teeth to work a hole which shall be big enough to let them through.

Their method of enlarging a crack to make a hole has been more than once observed by members of our expedition in McMurdo Sound, and the evidence is well supported by the condition of the teeth in a really old Weddell's Seal; this is well exemplified in the sample figured, where the canines and incisors are worn to rounded stumps (Seals, Pl. III.). The seal, fixing the canines and incisors of his lower jaw in the solid ice, begins to revolve the upper jaw about them, in this way using the teeth of the lower jaw as the fixed point of a centre-bit while those of the upper act as the cutting edge. This has not, to my knowledge, been previously observed, and it explains not only the very worn condition of the teeth, but also how new seal-holes rapidly appear in a narrow, fresh-formed crack in solid sea ice, even within a few hours, sometimes, of its opening. The seal has been known to work in the same way from below, and in this case one cannot but think that there must be sufficient air-space below the ice for breathing.

Further examples of the wearing down of the incisors and canines may be seen in Skulls Nos. 47, 48, 78, and 82 of the 'Discovery' Collection.

To return to the subject of progression, it is obvious that this power of making holes in the ice for entrance to or exit from the water has almost entirely done away with the necessity for any but the most perfunctory methods of progression on ice and land. The hind flippers certainly are never used at all except when the seal is in the water, and there is no tendency whatever under any conditions to attempt to bring them forward in progression. That there is still free and varied movement in every joint of the hind limb is, however, obvious from the fantastic positions that it assumes when the animal, as he so often does, stretches himself, or when he brings an irritable hind limb forward to be slowly and deliberately scratched by the long nails of the fore limb. The quaint attitudes thus exhibited are exemplified in several of the accompanying illustrations.

It is interesting to note in this connection, too, that although when lying on the ice these seals are often in a very irritable condition as regards their skin, a repeated and careful search failed to reveal any external parasites at all. It would appear that the animal is quite free from anything of the kind, and one is led to conjecture that the constant irritation as the animals lie sleeping in the sun, is due to the effect of evaporation on the salt water in their hair. It may be that the crystallisation of the salt, and the peculiar effect which drying has upon the hair itself, may cause the irritation, for the hair, instead of lying flat against the skin as it does when wet, takes

Fig. 18. Young Weddell's Seal, 10 days old.

Fig. 19. Young Weddell's Seal, in third week, showing commencement of moult on the shoulders.

*To face p. 22.*

up a recurved form as it dries, and roughens the whole coat by gradually standing up and curling backwards. This is a marked feature in the hair of Weddell's Seal, and was very noticeable in the various uses to which the dried skin was put upon the ship, such as the making of slippers, knife sheaths, gaiters, and so on; for when dry there was a good wire-haired furry skin, but no sooner was the hair exposed to moisture than the sleek and shiny texture of the wet seal was immediately reproduced. This change in drying, particularly from salt water, may have much to do with the apparent irritability of the skin of the basking seal.

Of the use of the fore limb when out of water there is little more to be said. The claws are not used offensively when the animal is disturbed to the same extent that they are in *Phoca vitulina*, for example. In the latter the whole action is that of a cat, but Weddell's Seal has not the same power that is possessed by *Phoca vitulina*, or *Ph. fœtida*, or even *Halichœrus*, of bringing the fore limb right forward from the shoulder. The limb is more perfectly webbed, and the web is much more closely continuous with the skin of the body than in these species, that is to say, there is in *Leptonychotes* less of an arm or wrist than in these northern seals.

This being so, one would expect that the nails would have lost something of their efficiency and of their size, but this is not the case. They are comparatively long and well formed, and reach well beyond the fleshy part of the digits. In the hinder limb the nails are not so well grown, nor are they in any sense functional. The nails of the fore limb, on the other hand, are, as I have said, constantly in use for scratching. In the infant the fore limbs are far more constantly brought forward than they are in the adult, and in this way the young *Leptonychotes* approximates to the true *Phocinæ* and *Halichœrus*. In the fore limb there is free power of flexion and extension as well as of abduction in all the digits, and the same may be seen in the hinder limbs.

There is, moreover, a very remarkable amount of precision in the power of directing the touch, and this is seen in the accuracy with which the apparently clumsy limb brings a single nail to bear on the irritable spot, whether it be on the face or head, on the breast or abdomen, or on the other flippers either before or behind.

All these remarks deal with Weddell's Seal on land, or rather on ice and snow. Certainly it is the most land-frequenting of all the Antarctic seals, indeed, it is never to be found in any numbers away from the actual shore, or, at any rate, from fast ice. This littoral habit, however, is not a primitive one retained by Weddell's Seal alone, whilst others, its near relations, have taken to the open seas; it is a habit of secondary development, into which the animal has fallen in these regions through a wish to shun the enemies that molest it in the open sea.

Few seals are more fully adapted to a pelagic life than *Leptonychotes*, and every feature of the animal helps to support this view, especially if we watch first the easy motion of a seal in the water, its clumsy efforts to land, and the still more clumsy gait that follows when at last the landing is effected. When there has been no need for haste a seal has been seen to make ten unsuccessful efforts to land on ice which was

not 6 inches above the water-level. Certainly such clumsiness is not quite usual, but one seldom sees less than two or three unfruitful efforts before the ungainly body is sufficiently out of water to hitch itself fairly on to the ice. In this effort the fore limbs are used, but to no great purpose, and the movements are all rather suggestive of those of a man tied up in a sack trying to get out of water on to land.

The seal swims mainly by the sinuous motion of its body, and in this movement the hind flippers are of the greatest service, forming a fish tail in the vertical plane when held, as they usually are, palm to palm, and a powerful horizontal fluke as in a whale, when there is necessity for rising or sinking in the water. The fore flippers are probably of more use in directing the course of the animal than in propelling it, and they must be increased nearer to the size of the sea lion's fins before they can be of very great service for swimming.

Of the colouring of *Leptonychotes* something still remains to be said.* The collection at present under consideration contains thirty-five skins, covering all ages and conditions of moult in both sexes. It is natural that in such a series there should be a certain amount of variation.

Weddell's Seal is to be found moulting at any time during the summer months, from the third week in November even to the end of March, for an adult seal has been observed just commencing to moult on the 19th of the latter month.

The order or sequence of parts from which the old hair is shed is much the same for *Leptonychotes* and *Lobodon.* Beginning in a line down the centre of the back from head to tail, the moult is almost simultaneous upon the head and upper neck, shoulders, fore and hind flippers. The old hair then begins to fall from all the lower parts—neck, chest and abdomen—while the last remnants of the old bleached hair are to be found on the sides of the body.

The change in colour thus brought about is often most remarkable. The old hair is a pale rusty gray where it once was black or dark gray, and the spots and splashes of white and silver gray, which appear in rich contrast with the black in the new coat, are disclosed by the falling of a rather dirty-looking whitish hair which is hardly whiter than the rusty gray which covered up the black. Yet this seal never looks white in the weathered coat, as does *Lobodon*; rather it looks a dingy brown with inconspicuous markings.

The weathered adult coat prepared to moult at any minute can be well seen in the following skins Nos. 4, 38, 47, 51, and 62 of the 'Discovery' collection.

The commencement of the moult is to be seen in skins Nos. 3 and 54; while the stage is rather more advanced in Nos. 23, 25, 48, 53, 60, 72, and 74. In Nos. 41, 55, and 73 the moult is almost completed, and quite completed in Nos. 49 and 50. In many of these the contrast between the old bleached and weathered hair, and the rich black and gray and pure silvery white of the new hair is very striking; markings

* In the Report on the 'Southern Cross' collections, the skins of the four species of Antarctic Seals were described, with coloured illustrations, by the Author of this paper.

Fig. 20. Young Weddell's Seal, two months old.

Fig. 21. Weddell's Seal, adult.

To face p. 24.

which appear dim and shadowy and ill-defined in the old coat, come out with startling contrast in the new. The summer sun undoubtedly plays the greater part in the bleaching, much more than the weathering of the preceding winter months. Weddell's Seal does not appear to shun the water while moulting.

These changes in coat are, however, distinct from differences due to individual variation. The skins of the present collection may be roughly divided into three types, not one of which is confined to any particular age, sex or locality.

I. The type in which the markings of black, white, and intermediate gray are large, bold, and in striking colour contrast. Of such are skins Nos. 35, 47, 49, 56, and 74.

II. The type in which the markings are all small and narrow, but very abundant and distinct, the white and black well contrasted. Of such are skins Nos. 40, 51, and 52.

III. The type in which the markings are few and indistinct; and of such are skins Nos. 36, 50, 62, and 72.

Variations in size are exceedingly common, but may all be considered as the result of differing age, not sex. Such differences are exemplified in the measurements of the following skins :—

| | Nose tip to tail tip. |
|---|---|
| No. 42, just born, in first week | 4 ft. 10 ins. |
| No. 45, in second week | 5 ft. 11 ins. |
| No. 86, three weeks old | 6 ft. 2 ins. |
| No. 2, about third month | 6 ft. 6 ins. |
| No. 51, at end of first year | 6 ft. 9 ins. |
| No. 53, in third year probably | 7 ft. 5 ins. |
| No. 3, fully adult | 10 ft. 0 ins. |

In the colouring of the adult Weddell's Seal, perhaps the most typical characteristic is that the palest area is not ventral and median, but lateral or ventro-lateral. The dorsum is typically black; then comes a dorso-lateral area which is black with a few white streaks or splashes; then a lateral area in which the white blotches are larger and more abundant; then a ventro-lateral area in which the white is predominant, and very few darker markings are to be seen; and lastly, the median ventral area is gray with white spots and streaks or splashes. The tail is, dorsally, the blackest part of all, but has a narrow white border which is constant.

The gray colour of the head starts round the nostrils and passes backwards to surround the eyes, except for a white superciliary spot over each eye. The gray of the head spreads backwards to include the shoulders and fore flippers, but on the shoulders there are often short and discreet white streaks. The fore flippers are blackish gray above, but whitish on the radial border and beneath; the hind flippers blackish gray above with whitish tibial border, but blackening towards the tips of the digits, which are bordered with a whitish edge, and where the nails are inserted, marked by a few white hairs. The nails are black, as also are the twisted facial bristles in the adult. These show no twist or wave in the young of the first few months. The hair at the corners of the mouth and at the excretory orifices is stained a deep chestnut brown.

Of the diseases of the Antarctic seals there is but little to be said. They are not exempt from the ravages of unfriendly bacteria, for one may see their wounds freely suppurating, and in more than one case the eyes both of adult and young have been seen streaming with pus. They are also apparently subject to uric acid troubles, for the kidney tubules have been found in one or two cases occupied completely by renal calculi. In the coronary arteries also, very definite atheromatous deposits may occasionally be found.

## STENORHINCHUS LEPTONYX.

*The Sea-Leopard.*

*Phoca leptonyx*, de Blainville, Journ. de Physique, etc., t. XCI. (1820), pp. 288–289 and 297–298.

*Stenorhinchus leptonyx*, F. Cuvier, Dict. Sci. Nat., XXXIX. (1826), p. 549.

*Ogmorhinus leptonyx*, Peters, Monatsb. k. Akad., Berlin (1875), p. 393 ; Barrett-Hamilton, Rep. 'Southern Cross' (1902), p. 25, *ibique citata* ; K. A. Andersson, Wiss. Ergeb. der Schwed. Südpolar-Exped., Bd. V. 2 (1905), pp. 11–13.

*Stenorhynchus leptonyx*, Brown, Mossman, and Pirie, Voy. 'Scotia,' (1902), pp. 122, 222, 227.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 64, ♀, ad. skin and skull. Jan. 7, 1902. Pack ice, Ross Sea, 68° S. 175° E. (*Mounted for the B. M. Gallery by Rowland Ward.*)

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 18, M. 7. ♀, ad. skin. Dec. 28, 1902. Pack ice, Ross Sea, 68° 55′ S. 175° 26′ E.
No. 65, M. 30. ♂, ad. skin and skull. Jan. 1904. Pack ice, Ross Sea, 68° S. 173° E.
No. 66, M. 27. ♀, ad. sk. Jan. 1904. Pack ice, Ross Sea, 69° S. 178° E.

FOR the history of the type specimens, and of the earliest descriptions of this seal, I must refer my readers to the account given by Captain Barrett Hamilton under *Ogmorhinus* in the Report on the 'Southern Cross' Collections (pp. 25–27). The synonomy there given also covers the matter so completely that I could but quote the paragraph word for word. I venture in this paper, however, to return to *Stenorhinchus*, a name which is certainly open to objection, but not perhaps to so much as are *Ogmorhinus* and *Stenorhynchus*, while it is certainly preferable to *Hydrurga*.

*Stenorhinchus*, then, has a very extensive range, not only far to the south and within the Antarctic Circle, but also throughout the Southern temperate regions. It has been recorded, for example, from the Falklands, Campbell Island, Desolation Island, New Georgia, Lord Howe Island, Tasmania, Cape Horn, New South Wales, Patagonia, Kerguelen, and various parts of the coast of New Zealand (Port Nicholson and Wellington Harbour, the Waikato and Wanganui rivers), where Sir James Hector says it is a common but a solitary animal. "It frequently comes on shore, and, notwithstanding its feeble powers of locomotion, scrambles far back into the bush in flat country, and occasionally ascends rivers for a long distance." Farther south, Captain Larsen reported it from Louis Philippe Land in November, Mr. Bruce from Graham's Land, and Mr. Borchgrevink from Robertson Bay in September. Sir

Fig. 21a. Adult Weddell's Seal Travelling on Ice.

Fig. 21b. Young Weddell's Seal in the First Week.

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James Ross obtained it in the Antarctic pack-ice to the north of Ross Sea, as also did the 'Southern Cross' and the 'Belgica' later on. More recently it has been reported by the Scottish Expedition from the South Orkneys, and by the Swedish Expedition from South Georgia, and from 65° 19′ S. lat. in 56° 48′ W. long.

In the 'Discovery,' during our passage through the pack to the north of Ross Sea in January, we saw one example only, which we procured (fig. 22, p. 28). It was an adult female, and in full milk, but we saw no sign of a young one. On our homeward voyage we again saw two examples in loose and disintegrating pack-ice, on March 1st, quite close to the Balleny Islands.

The 'Morning' procured three examples also in the Ross Sea pack, about 68° and 69° S. lat. in 173° and 178° E. long.

The identity of this seal has, I think, on many occasions been mistaken. Mr. Borchgrevink seems to have confused the two so-called Leopard Seals, and quite habitually speaks of the Sea Leopard (*Stenorhinchus leptonyx*) when giving an excellent description of *Leptonychotes weddelli*. Mr. Bruce also appears to have made the same mistake in Graham's Land. *Stenorhinchus* is a solitary animal,* and the seals which he saw in "a great host, moaning loudly," must surely have been Weddell's Seals. I can also understand Dr. Donald's note that "the females of the larger species were larger than the males" only by believing that the animals he speaks of were Weddell's Seals.

It is with all due deference that I urge such criticisms, but it is well to correct, if possible, misapprehensions which have arisen from these accounts, for *Stenorhinchus*, above all things, is in the Antarctic ice a widely scattered species, not found in large herds, and not "one of the two best-represented seals in the pack-ice near Victoria Land," as Mr. Borchgrevink has stated; nor can it be said to breed in Robertson Bay, except possibly on very rare occasions. *Leptonychotes*, on the other hand, does all these things, and it is of *Leptonychotes* that they should rightly have been recorded.

Mr. Moseley's note of a herd of 400 of these animals at Kerguelen Island is perhaps less open to doubt. It is more probable, however, that this was a collection of *Stenorhinchus* than of *Leptonychotes.* It is just possible that it was neither, although both are known to have occurred there.

But it may here be pointed out that we know practically nothing of the breeding habits of *Stenorhinchus*, and that it may collect for the purpose of breeding in the outlying islands of such places as Kerguelen. It seems occasionally to produce its young in the Antarctic pack ice, or in the neighbourhood of Antarctic lands, but no account has ever yet been given of anything approaching an undoubted 'rookery' in the Antarctic. The 'Southern Cross' Expedition claimed to have found it breeding in Robertson Bay, but the animal instanced seems really to have been *Leptcnychotes*, which bred freely there.

The contour of *Stenorhinchus*, as may be judged from various photographs that

* Compare also Dr. Andersson's account of this animal in South Georgia: "Es kam vor, das wir dort bis zu 10 Stück auf demselben Strande nicht weit von einander sahen, aber sie schienen in keiner Weise sich um einander zu kümmern, so dass er keinesfalls als ein geselliges Tier zu bezeichnen ist." *Op. cit.*, p. 11.

have been published, notably an excellent one by Mr. Bernacchi in his narrative of the 'Southern Cross' Expedition, and in the 'Southern Cross' Report (p. 26), is markedly different to all the other species. The head is disproportionately large for the rest of the body, and the power of the neck is immense. The rest of the animal tails off in a more snake-like fashion than in any other of the Southern seals, suggesting great power and rapidity of movement under water. The total length from nose to tail tip of the four specimens in our collection is respectively 128 inches in No. 64, 106 inches in No. 65, 131 inches in No. 66, and 107 in No. 18. These figures, however, do not give a true idea of the size to which the animal may grow, for Sir James Ross captured one with a length of 144 inches. The proportions of the animal will be better understood by the following measurements, which were in each case taken in the flesh, and it may here be noted that the example recently mounted in the British Museum Gallery (No. 64 of the 'Discovery' collection), was modelled carefully to these figures, so that its form represents as nearly as possible the proportions of life:—

Nose to tail tip ... ... ... ... ... ... 128 inches.

Diameter, taken with callipers from side to side :—

| | |
|---|---|
| At a point 12 inches behind the nose ... ... ... ... ... | 11 inches. |
| " 24 " " " ... ... ... ... ... | 17½ " |
| " 36 " " " ... ... ... ... ... | 29 " |
| " 48 " " " ... ... ... ... ... | 23 " |
| " 60 " " " ... ... ... ... ... | 20 " |
| " 72 " " " ... ... ... ... ... | 19½ " |
| " 84 " " " ... ... ... ... ... | 16 " |
| " 96 " " " ... ... ... ... ... | 16 " |
| " 108 " " " ... ... ... ... ... | 13 " |

The end of the fore flipper, lying along the side, was 62½ inches from the nose.
At a point 90 inches from the nose was the smallest diameter of the belly, 15 inches.

The following dimensions were taken by Dr. Davidson from examples captured on the 'Morning,' :—

| | No. 65 ♂. Inches. | No. 66 ♀. Inches. | No. 18 ♀. Inches. |
|---|---|---|---|
| Length from tip of nose to end of tail ... ... | 106 | 131 | 107 |
| Greatest girth ... ... ... ... ... ... | 57 | 75½ | — |
| Length of fore flipper ... ... ... ... ... | 22 | 29½ | 29½ |
| Breadth " " ... ... ... ... ... | 13 | 16 | 14 |
| Length of hind flipper ... ... ... ... ... | 21 | 24 | 21 |
| Spread " " ... ... ... ... ... | 22 | 26 | 27½ |
| Girth under the fore flippers ... ... ... | — | — | 56½ |
| Girth above the tail ... ... ... ... | — | — | 37 |

In the stomach of the specimen which we procured were the remains, almost a complete skin, of an Emperor penguin, 3 feet in length. In the stomach of one taken by Dr. Davidson, on the 'Morning,' were the remains of a young Weddell's Seal. Fish, cephalopods and penguins seem to form its chief diet in the Antarctic seas, and in one instance 28lbs. of fish are reported to have been taken from the stomach of a single animal. On the ice floes it seems to be even less active than Weddell's

FIG. 22. HEAD OF SEA LEOPARD, ADULT ♀.

*To face p.* 28.

Seal*; but whereas in the latter this is due to excessive fatness, in the former it seems to result from the disproportionate weight of the head and shoulders. Nor are these capable of being reared high off the ice, as they are in the case of the Sea Elephant, whose fore flippers are still of some service as a support to the massive head and shoulders. In *Stenorhinchus* the flippers, both hind and fore, are essentially swimming organs, and to this end are long and powerful, with the first and fifth digits of the hind flippers broadly palmated at the tips beyond the nails, though all the flippers, both hind and fore, are still completely clothed with hair. The nails are fairly well developed in the fore limbs, the first alone being rudimentary, the other four reaching well beyond the edge of each digit. In the hind limb the nails of the first and fifth are small and rudimentary, those of the second and fourth well formed and reaching to the edge of the digits, while that of the third reaches well beyond.

*Stenorhinchus* is not so immune from the attacks of the Killer Whales as one might infer from its size and strength. It has been reported in one case, a young animal it is true, to have been seen very badly torn by wounds of the typical character. No. 18 of our own collection has an extensive healed scar upon the crown of the head, but of a shape which suggests rather damage done by moving ice floes than by a Killer Whale.

*Stenorhinchus* is at once to be distinguished from all other seals by its cheek teeth, which are not only larger and more powerful than those of any other Antarctic form, but shaped each like a trident, with three long pointed cusps standing vertically to the long axis of the jaws. The points of the two outer cusps in each tooth are curved slightly towards the longer central one, which has itself also a slight curve backwards.

The typical marking of the skin of this seal has been already detailed in the 'Southern Cross' report, and I have only here to add that the orange tint which characterises the great majority of Museum seal skins, not only of this, but of all the Antarctic species, is only less misleading in this case than in any of the other forms, since the living *Stenorhinchus* has in some cases a tawny tint, characterising the weathered coat. This, when shed, is replaced by hair of as pure a grey as occurs in any other of the seals. The younger animals appear to be of a more silvery grey than the older. The orange tint, which is so very marked a feature in the majority of Museum seal skins, particularly of the earlier specimens, is, in the case of *Lobodon*, *Leptonychotes*, and *Ommatophoca*, wholly misleading, not one of them having anything approaching it in life. It results chiefly from the gradual absorption of disorganised fat into the hair, fat which, in life, is almost colourless, but becomes dark yellow after death and in the course of time. The only tendency to a brown colouration in the living Antarctic seals is in the hair of the weathered coats; but this is always of a very moderate tone, and never approaches orange yellow; it should rather be described as a brownish buff in *Lobodon*, and a dusky brown in all the others.

* See, however, Voy. of 'Scotia,' *op. cit.*, p. 222, where Dr. Pirie writes that this seal "has been seen to come up alongside a floe on which the penguins were resting, seize one in its huge jaws, and sweep down again with its prey."

There appears to be a good deal of individual variation in the extent and distribution of the pigmentation in the hair of *Stenorhinchus.* The four skins in the 'Discovery' and 'Morning' collections, although having in each case the main distinctive character, are strikingly different in this respect. No. 66, for example, is an exceedingly handsome skin, richly marked with jet black and dark grey, particularly upon the throat, shoulders, flanks and hind flippers. These are the usual areas upon which the dark markings appear, or, rather, one should say remain ; for the character of the marking in all of the Antarctic seals is such that one may more easily consider it brought about by the greater or lesser confluence of white spots upon a dark ground. This is the case even in *Lobodon,* where the white spots are confluent to such an extent that in many cases no trace of the ground colour is left. This is the case also, and to a considerable extent, in *Stenorhinchus* and *Leptonychotes.* It is less apparent in *Ommatophoca.* The result of the partial confluence of white spots in young examples of *Lobodon,* and in all examples of *Stenorhinchus,* is that rings, more or less complete, of pigmented hair remain to form the characteristic dappling on certain areas, these being constant in each case. The first part of the body to be wholly whitened is the abdomen and the throat, the last the back and dorsal aspects of the limbs and sides of the head. In No. 66 the pigmentation is much in excess of the average, so that there are even black markings remaining on the abdomen, and the throat is very richly marked. For descriptive purposes, the skin of *Stenorhinchus* may be conveniently divided into a dorsal, a ventral and an intermediate lateral area. The first is dark grey with black markings, the second is pale with no marking as a rule, the third is grey, freely spotted with both black and white. Specimen No. 65 is a richly marked skin, but of a different type to No. 66. The dorsal area is dark grey but with multitudinous and small black markings, the lateral area freely spotted with white and black, and the ventral area, particularly the throat, but slightly marked with black. No. 18 is again a third type, with few and indistinct markings, being of a rather dirty grey colour dorsally and ventrally, and only a pale grey below; yet there is no doubt, even in this poorly-marked skin, that the distribution and appearance of the darker markings is characteristic of *Stenorhinchus.*

It is a significant fact that in the ten skulls of *Stenorhinchus* now in the British Museum, there is to be found no variation at all in respect of the number, either of the incisors or of the cheek teeth. In each case the formula is strictly *Stenorhinchine,*

$$\mathrm{I.}\ \frac{2-2}{2-2}\ \mathrm{C.}\ \frac{1-1}{1-1}\ \mathrm{P.\ C.}\ \frac{5-5}{5-5}.$$

This uniformity in a species of the true seals is quite unusual. *Lobodon carcinophagus, Phoca greenlandica,* and *Stenorhinchus leptonyx* are the only species in which I have been unable to discover aberrant dental formulæ. This point is obviously connected with efficiency from a functional point of view, for the teeth are strong and well adapted to the food upon which their owners live, although they are in each case also highly specialised in form.

## LOBODON CARCINOPHAGUS.

*The White Antarctic or Crab-eating Seal.*

*Phoca carcinophaga,* Jacquinot and Pucheran, Zool. Atlas Voy. Pole Sud., pl. X., Xa. (1842–1853).

*Lobodon carcinophagus,* J. E. Gray, Zool. Voy. Ereb. and Terr., Vol. I., Mamm. (1844), pp. 5, 6, Pls. I., II.; Barrett Hamilton, Rep. 'South. Cross' Coll. (1902), p. 35, *ibique citata*; Brown, Mossman, and Pirie, Voy. 'Scotia,' (1906), p. 122.

*Lobodon carcinophaga,* K. A. Andersson, Wiss. Ergeb. der Schwed. Südpolar-Exped. Bd. V. 2 (1905), pp. 13–16.

List of Material in the 'Discovery's' Collection.

No. 5, ♂, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 6, ♀, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 8, ♂, adult skin and broken skull. January, 1902. Pack ice. Ross Sea.
No. 9, ♂, adult skin and broken skull. January, 1902. Pack ice. Ross Sea.
No. 10, ♀, adult skin and broken skull. January, 1902. Pack ice. Ross Sea.
No. 28, ♀, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 29, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 30, ♀, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 39, ♀, adult skin and skull. January, 1902. Pack ice. Ross Sea.
No. 12, ♂, ad. skin and skull. January, 1902. Pack ice. Ross Sea. 67° S. 178° E. (*Mounted for B. M. Gallery by Rowland Ward.*)
No. 75, ad. skull. McMurdo Sound.
No. 79, ♂ ad. skull. McMurdo Sound.
No. 83, ad. skull. One of N. Hanson's, picked up by me at Cape Adare.
Also the skeleton of an adult ♂.

Material in the 'Morning's' Collection.

No. 76, M. 10, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea. 67° S. 179° E.
No. 7, M. 20, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea.
No. 15, M. 8, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea. 66° S. 179° W.
No. 17 (M. 8)[a], ♀, juv. skin and skull. January, 1903. Pack ice. Ross Sea. 70° S. 175° E.
No. 57, M. 12, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea. 67° S. 179° E.
No. 59, M. 19, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea.
No. 63, M. 7, ♀, adult skin and skull. January, 1903. Pack ice. Ross Sea.
No. 61, M. 11, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea. 69° S. 179° E.
No. 58, M. 9, ♂, adult skin and skull. January, 1903. Pack ice. Ross Sea. 66° S. 179° W.
No. 19 (M. 9)[a], ♀, juv. skin and skull. January, 1903. Pack ice. Ross Sea. 70° S. 175° E.
No. 20 (M. 5), ♂, juv. skin. December 27, 1902. Pack ice. Ross Sea. 68° S. 176° 54′ E.
No. 21 (M. 10)[a], ♂, skin and skull. January 1, 1903. Pack ice. Ross Sea. 70° S. 175° E.
No. 22 (M. 1), ♂, adult skin and skull. January. Pack ice. Ross Sea.
Also the skeleton of an ad. ♂.

*Lobodon* has been seen by almost every expedition that has entered the Antarctic pack ice, and in all probability it is to be found all round the Antarctic Circle. Stray examples have been recorded, as with other similar species, from the most unexpected quarters. A specimen, now said to be in the La Plata Museum, was taken near San Sidro, north of Buenos Ayres, in lat. 34° 28′ S., while other two examples have been taken on the coast of Australia, the one at Melbourne, the other at Portland, Victoria, in 1897 and 1894 respectively (see "Nature," February 5th, 1903, p. 327); these are

of course, merely wanderers. The limits of this seal's normal range are probably as far south as open water can be found, at present as far south as lat. 77° 50′ in McMurdo Sound, and as far north as the more heavy pack ice has now been known to drift, which may be roughly stated as varying between 58° and 60° S. lat.

The history of the type specimen of this species has been briefly and clearly stated by Captain Barrett Hamilton in the Report on the 'Southern Cross' Collections, and to this I have nothing to add. It appears that after Gray had described the skins and skulls brought home by Sir James Ross, the written descriptions of the same animal, figured previously in the Zoological Atlas of the French Voyage to the South Pole, made its appearance. Gray recognising his specimens as belonging to the same species, accepted the specific name *Carcinophaga*, while the French naturalists adopted *Lobodon* as the generic name proposed by Gray. The University Museum of Zoology at Cambridge is in possession of one of the skulls brought home by the Dumont D'Urville Expedition. Owen's description of *Stenorhynchus serridens* was taken from a skeleton brought home by Dr. McCormick of the 'Erebus' and 'Terror' Expedition, and presented by him to the Royal College of Surgeons of England.

Much still remains to be discovered concerning the life history of this seal; the fact that it is to be found chiefly in the pack ice of the open sea, and rarely along the actual coast line, sufficiently explains why our knowledge of its habits should be so limited. Its young, no doubt, are born into the world about the same time as the young of the other Antarctic seals, namely in the latter end of September and the beginning of October, fully a month or six weeks before it is advisable for any exploring ship to attempt the passage of the pack. Consequently the young *Lobodon* in its infantile coat of rough white fur has been very rarely seen, and no expedition except the Belgian (1897–99) has, to my knowledge, had the good fortune to obtain an example in this stage, for no other expedition has wintered in the pack.

There can be no doubt, I think, that *Lobodon* spends the whole of its time throughout the year in the pack. We know that it is to be seen there in comparatively large numbers during the summer months, from the accounts which have been given by expeditions from the earliest days. It is the common seal of the pack ice. For every example of Ross's Seal or of the Sea Leopard, some fifty or sixty of *Lobodon* are regularly seen in the Ross Sea pack.

Weddell's Seal is rarely away from land or fast ice; so rarely that in our passage through the pack, not one was seen, and it was not until we had come close in shore towards Cape Adare that we met with it at all; but during our passage through the pack ice early in January we constantly came across small companies of Crab-eaters lying asleep upon the ice floes. Often they were to be seen singly, often in couples, but even more commonly in small groups of five, six, or more together, and of both sexes. Sometimes they would be lying on their backs, and sometimes on their bellies, one position seemed to suit them just as well as another. It is interesting to contrast the distribution of these two species, *Lobodon*

FIG. 23. CRAB-EATING SEAL, ADULT.

FIG. 24. HEAD OF ADULT CRAB-EATING SEAL.

*To face p. 32.*

and *Leptonychotes*, since they are by far the most abundant of the five seals now known to occur within the Antarctic circle.

*Ommatophoca* is still a rarity; *Stenorhinchus*, though less rare, is very sparsely distributed, and *Macrorhinus* can only be considered a very occasional visitor, thus leaving *Leptonychotes* and *Lobodon* as the two seals that occur in great numbers to share the field between them. This they have done by differentiating both in habit of life and in diet, *Lobodon* living mainly upon crustaceans, and *Leptonychotes* almost wholly upon fish.

It is noticeable that the two penguins which share the same area have differentiated in a somewhat similar manner, the Emperor living almost entirely upon fish, and the Adélie Penguin almost entirely upon crustaceans. If we press the similarity even further, we shall see that Weddell's Seal and the Emperor Penguin have similarities which are distinct from the similarities that exist between the Crab-eater and the Adélie Penguin.

The first two have the following points in common, namely, a littoral distribution, a fish diet, and residental non-migratory habit, remaining as far south the whole year round as open water will allow; whereas the other two, *Lobodon* and *Pygoscelis adeliæ*, have in common a more pelagic habit, a crustacean diet, and a distribution definitely migratory in the case of the penguin, and although not so definitely migratory in the case of the seal, yet checked from coming so far south as Weddell's Seal in winter by a strong tendency to keep in touch with pelagic ice. By this differentiation, the interests of *Lobodon* and *Leptonychotes* are saved from clashing, as are also the interests of the two penguins; and the advantage in each case rests apparently with the non-migratory and more southern species. For one thing, at any rate, both Weddell's Seal and the Emperor Penguin are very much more free from the attack of beasts and birds of prey than are either *Lobodon* or *Pygoscelis adeliæ*.

The attentions of *Orca gladiator* are confined almost wholly to *Lobodon*, and those of *Megalestris maccormicki* almost wholly to *Pygoscelis adeliæ*. Neither *Orca* nor *Megalestris* can be considered to play any great part in the life history of Weddell's Seal or of the Emperor Penguin. In this respect, no doubt, these two animals have made a great advance by accommodating themselves to the winter conditions which prevail in the highest latitudes where water, and therefore food, can by any means be obtained.

There is, at present, but slender basis for saying that *Lobodon* is a migratory seal in any sense, but it was noticeable that so long as open water was within a mile or two of our winter quarters, we were occasionally visited by this seal, whereas it entirely disappeared and was not once seen when and so long as five or ten miles of solid ice separated us from open water; although *Leptonychotes*, as I have already shown, was almost as abundant as before.

In the month of February, for example, during our first year in McMurdo Sound, we saw three Crab-eaters on the 25th, and these remained with us till the

9th of April. Others, also, appeared at various times a short distance from the edge of the unbroken ice, but only so long as the open water was quite easily within reach, as it was even into the second week of May. Then the whole strait became once more frozen over, and this sheet of ice remained unbroken for close on two years, during which time the open water was never nearer to us than five miles, and much more generally was ten to twenty miles away.

From the day when the sea froze over we had no more visits from the Crab-eaters. They shunned the fast ice and frequented only its margin and the pack. The reason of this may be that the crustacea on which they feed are abundant only in the open pack, and we know that *Euphausiæ* are not common under the fast ice. Nearly two years later, when the ice again broke up in McMurdo Sound, a single *Lobodon* made its appearance, a male, considerably battle-scarred and weather-worn. It had been freely eating a red seaweed, with which we found the stomach filled. It is possible, however, that this animal was sick, and that in thus entering the strait at all it was following the instinct of retirement in sickness and approaching death, upon which I have dwelt more fully in speaking of Weddell's Seal.

Certain it is that *Lobodon*, notwithstanding its pelagic habit of life, even more than *Leptonychotes*, tends to wander great distances at the approach of death, and to extraordinary heights up the glaciers of South Victoria Land. Thirty miles from the sea shore and 3000 feet above sea level, their carcases were found on quite a number of occasions, and it is hard to account for such vagaries on other grounds than that a sick animal will go any distance to get away from its companions.

In the extracts from the late Mr. Hanson's diary, published in the 'Southern Cross' Report (p. 95), the same point is touched upon, though the carcases in this case were discovered, not at great heights upon the glaciers, but at sea level. He says :—" This afternoon I commenced digging out some seal mummies. I found in all twelve of them." His list includes eight Crab-eaters, two Weddell's Seals, and two that were indeterminable. Only one of the twelve was not adult or old, and he proceeds to say :—" What does this list tell us ? Shall we here find a solution of the zoological problem, Where do the Antarctic seals bring forth their young ? It would be of great interest to get the problem solved, as the life and resort of the seals during the breeding season is entirely unknown." One of the Crab-eaters he found was a " female with embryo."

On September 14th, a short month before his death, Nicolai Hanson wrote again in his diary :—" To-day something of great zoological interest happened. Fougner found a male white seal far up in the land (about 500 metres) under the mountain. As he was very savage and wanted to attack Fougner when he approached him, he had to return to the hut and call Evans to come to his assistance with a rifle. . . . To judge by the colour it was an exceedingly old animal—white as chalk—and he had not a sound tooth in his jaws. In the skin there was a number of large scars, but all old ; the peritoneum was full of innumerable small black hard tumours

as big as shot of all sizes. What has brought this old seal on shore? To judge by his tracks he has stayed there several days. He was presumably ill, as he was very lean, with only about half an inch of fat. Perhaps this is a solution of the question as to where all the dead seals come from which I have found scattered about on the point here and in the guano; perhaps this is a burial-place for old seals, and they crawl on land here to die. If this is so, my first supposition that all the seal mummies are due to its being a breeding-place for the White Seal is thereby knocked on the head; but this does not decrease the interest of my last conjecture."

On October 14th, 1899, Hanson died, his great wish—the investigation of the breeding habits of the White Seal—remaining unfulfilled. We know but little more of their breeding habits now than he knew then, but we do know, that where he was stationed at Cape Adare, there was no possibility of discovering more, and indeed the only light that has been thrown upon the matter has come from the pack ice farther north.

Dr. Racovitza, of the 'Belgica,' procured and photographed a young *Lobodon* immediately after its birth. This animal he has thus described:—"Le jeune unique est couvert d'une épaisse fourrure, de la même couleur que celle des parents, mais beaucoup plus fournie. Le bébé, au moment de sa naissance, a une taille considérable; 1·15 mètre (= 3 feet 9 inches); il possède déjà des dents et des yeux parfaitement fonctionnels et même une couche de graisse sous-cutanée efficace pour le protéger du froid. Il peut donc immédiatement se tirer d'affaire tout seul; aussi la mère l'abandonne-t-elle après l'avoir allaité seulement deux ou trois jours."

By no other expedition has so young an example of this seal been brought home. In the 'Discovery' we had no better fortune than the other expeditions which were in the Antarctic with us. We can only say therefore that the Crab-eater breeds neither along the coasts or coastal ice nor on the Barrier ice of the Antarctic land masses, conjecturing with almost certainty that it breeds always in the pack ice of the more open seas. The appearance of the young at birth in September we know from the above description and from a photograph reproduced in Dr. Racovitza's paper. But, in its early independence and in the very speedy desertion of its mother this seal differs from Weddell's Seal, which not only tends but suckles its young for at least five weeks and often more after birth, and quite constantly for a week or two after the infant has shed its natal woolly coat and entered water.

The adult Crab-eater differs markedly in build from the heavy, phlegmatic unwieldy Weddell's Seal, for although in length it ranges up to 9 feet from the tip of the nose to the end of the tail flippers, it has never the bulk that characterises the Weddell's Seal. It is long and slim, tailing off gently from the shoulders backwards (figs. 23 and 24, p. 32). The neck is long, and merges also gently with the head, which has an elongated appearance from the lengthening of the snout. The snout is distinctly pig-like, and can be given a turned-up, truncated look when the animal is in fear or otherwise excited, and the nostrils are dilated.

One would have no doubt, judging merely from its outward appearance, that it had some need for a far greater agility than Weddell's Seal, and this is shown when the animal is disturbed, first in attack and then in flight. In attacking man or dogs, it rushes forward first with open mouth and a husky roar, and then as quickly makes off for the nearest hole to reach the water. In character, as in appearance, *Lobodon* is the most active of all the Antarctic seals on land or ice, but probably is inferior to the others in point of speed while under water. It is usually aggressive when disturbed, and, in comparison with *Leptonychotes*, might certainly be called "neurotic."

Its progression on ice is far more rapid than that of Weddell's seal, and its movements when alarmed become as nearly as possible quadrupedal; for while the lithe and active body takes on the motion of a fish, the fore limbs, instead of lying idle along the sides, as in Weddell's Seal, assume an alternating action, exactly as they would in a four-legged beast. The hind limbs, of course, are functionless as legs, and cannot be brought forward as those of the Eared Seals can; but the rapid movement of *Lobodon* when thoroughly alarmed, rushing along as it does with head erect in a sinuous, snake-like course, is strongly suggestive of some fairly recent four-legged antecedent. It has, of course, also the characteristic "looper-like" method of progression, in which the body is alternately hitched up and shot forward from the chest and pubes, and this method it has in common with Weddell's Seal. The other mode of progression seems peculiar to itself. In the water it is naturally more active still, and this activity is probably needful to it, more for escaping from its arch-enemy, the Killer Whale, than for procuring food.

As Captain Barrett Hamilton has pointed out, the long, pig-like snout and the peculiar character of its teeth, which close upon one another to form a sieve, have both to do with its method of capturing the crustaceans (mainly *Euphausiæ*) upon which it feeds. Either at the bottom of shallow seas, or along the "foot" or submerged ledges of bergs and floes, it stirs up both mud and grit and gravel, taking these in freely with the crustaceans that are stirred up with them. The arrangement of the cusps in the teeth of both jaws, then coming into play, allows the water to drain out before the remaining contents of the mouth are swallowed. This development of cusps in the teeth of the *Lobodon* is probably a more perfect adaptation to this purpose than in any other mammal, and has been produced at the cost of all usefulness in the teeth as grinders. The grit, however, which forms a fairly constant part of the contents of the stomach and intestines, serves, no doubt, to grind up the shells of the crustaceans, and in this way the necessity for grinders is completely obviated.

In a few rare cases there is seen to be some wear, however, in the teeth, and this always in the skulls of the oldest seals. Such wear is not easily accounted for, but may follow, I think, from some change of habit or of diet in old age, perhaps, as in Weddell's Seal, from opening ice-holes in a secluded bay, or from changing to a seaweed diet, as above suggested. The delicate nature of the cusps, one might think, would lead to frequent damage, but this is not the case; and though it is

quite a common thing to find grains of sand and grit wedged in immovably between them, they are very rarely broken. If in extreme old age a seaweed diet is preferred, it is possible that in wrenching this from the rocks upon which it grows, the teeth might show some such effect in wear, though one thing is certain, that in the great majority of adult skulls there is hardly any sign of wear at all. Occasionally the remains of some small fish are found in the stomach of this seal mixed up with the *Euphausiæ*, but the latter form its diet in the main, and, measuring up to half an inch or more, may often be found undamaged in the contents of the stomach. The pigment of this schizopod is passed unaltered in colour in the excreta, colouring them brick red. It surprised us not a little, after reading that the stomachs of all the seals which Mr. Borchgrevink saw captured in the pack were empty, to find that the stomachs of those we captured, in the same month, and in the same state of partial moult, were replete with food. The moulting Crab-eater neither shuns water nor prefers to starve while his coat is being shed (see Author's notes in 'Southern Cross' Report), and the discrepancy between our respective observations must have been accidental.

The moult of *Lobodon*, which occurs in January and February, follows a regular course, beginning, as in Weddell's Seal, on the limbs both hind and fore, and spreading in a line from the head to the tail, mid-dorsally. From this it spreads down the sides, and also from the belly, the sides often retaining some old bleached hair for a considerable time. The change in colour resulting from the moult varies a good deal, not according to the sex, but according to the age of the individual. Young adult Crab-eaters, when freshly moulted, are very handsome animals, for their hair is unusually silvery, not white, but grey, and the ring-marks which appear very constantly on the flanks, shoulders, and sides of the head are of a rich chocolate brown colour. One example was brought home from Cape Adare by the 'Southern Cross' Expedition, which represented the stage of transition from the natal moult. Before it was tanned it had a good deal of the long whitish wool that characterises the infant at birth, as in the example which was procured by the 'Belgica' Expedition. This fur was lost, unfortunately, in the tanning process, as it was actually being moulted when the seal was killed, and the coat which appeared beneath showed only the usual mottling of the young adult.

This mottling is a very variable feature even in the unweathered phase which immediately follows the moult. As a whole the hair is silky and of a warm brownish grey, darker mid-dorsally, silvery white ventrally, and ring-marked with a rich warm brown. The ground colour, so to speak, of the whole animal is this dark brown, and upon it the silver grey may be considered to have been developed in the shape of oval spots, but to so great an extent that the spots are confluent over the whole body, except on the flanks, shoulders, sides of upper neck or head, and to a very variable extent over the remainder of the body. In one specimen, which unfortunately was not procured, as also in No. 19 of the 'Discovery' collection, the white spots are not altogether confluent on any part of the body, the result being a beautifully spotted seal.

It must be understood therefore that in the least mottled examples the dark brown colour appears only on the flippers hind and fore, and in the shape of a few more or less perfect rings on the head, tail, flanks, and shoulders. Plate IV., and Fig. 3 of Plate V. in the 'Southern Cross' Report, which are from coloured drawings of my own, represent sufficiently the points to which I have here referred, and I have not deemed it necessary to repeat them. These two plates also illustrate the changes which this seal undergoes in the course of the ensuing year. The whole coat changes, gradually during the winter months, and much more rapidly during the summer, to a creamy whiteness by bleaching, while the dark brown ring-marks and the flippers also fade to a pale and often hardly discernible buff. I speak still only of the young adults. The result of this bleaching is to produce a creamy-coloured seal, which has in consequence been named the "White" Antarctic Seal. It is applicable only to the bleached and weathered coat of summer, which is once more shed in January for the darker brown. In Plate V. of the 'Southern Cross' Report are shown first the bleached and weathered hinder quarters of a young adult in Fig. 1, then the moult commenced in Fig. 2, and lastly the new coat in Fig. 3. As age advances, and particularly in the males, the development of the paler shades becomes more and more complete, until in advanced age there is no longer any trace to be found of the dark brown under-colour, and neither ring-marks nor mottling make their appearance either in the new coat or the old.

Thus one may describe the most common phase of all as a seal of uniformly pale colouring, creamy white in the weathered coat, and brownish grey with silvery tones throughout in the newly moulted animal.

The following analysis of the skins in the present collection will give some idea of the comparative frequency of the various phases :—

i. White or buff skins with no markings, Nos. 5, 6, 7, 8, 9, 10, 11, 15, 20, 21, 22, 30, 57, 58, 61, 63.
ii. Skins with some faint markings, Nos. 17, 29, 59 (the last with marks on hind quarters only).
iii. Skins with distinct and extensive markings, Nos. 19, 28, 39.

Skin No. 39 is exceptionally handsome ; along the top of the head and back it is silver-grey, but along the sides, from the face to the flanks, the white spots or splashes are distinct from one another, leaving more or less chocolate-brown in the form of ring marks between them. The fore and hind flippers are chocolate-brown, and the tail brown spotted with white. It is the confluence of the white spots which causes the loss of the characteristic dappling. The whiskers are twisted, each on its own axis, as is the case with all the Antarctic seals. Each bristle is white with the terminal third black. The iris is dark brown, and the reflex to be seen in the vertical slit-like pupil when it opens to a lozenge shape is a brilliant emerald green. If the hair of *Lobodon* is examined it is found to be rather more than half an inch in length, quite straight and tapering finely to a point after coming to its greatest thickness about a quarter of its length from the root. In the hairs of an old white seal no trace of pigment granules can be found.

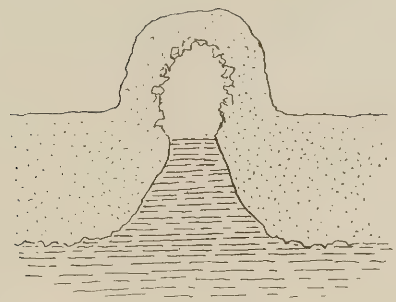


Fig. 25. Domed Blow-hole of Weddell's Seal, *see* p. 21.

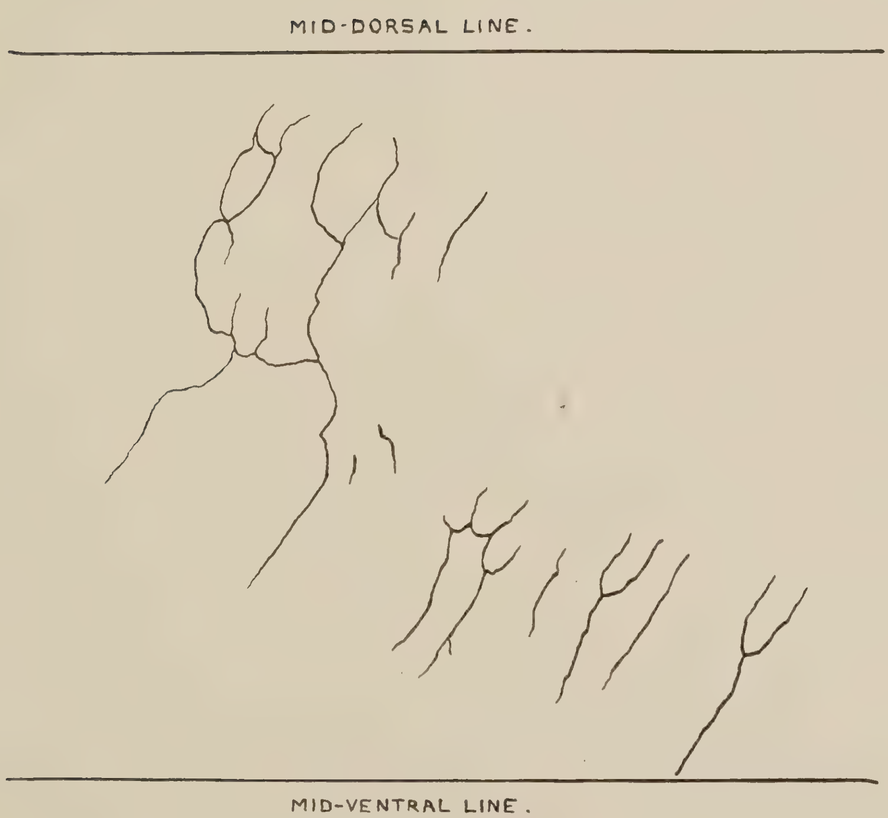



Fig. 26. Scars in Skin of *Lobodon* ($\frac{1}{5}$ nat. size), *see* p. 40.

*To face p.* 38

The following table gives measurements, taken in the flesh, of specimens collected by Dr. Davidson, on the 'Morning':—

| | Sex. | Nose to tail, in inches. | Greatest girth, in inches. | Length of foreflipper, in inches. | Breadth of foreflipper, in inches. | Length of hindflipper, in inches. | Spread of hindflipper, in inches. |
|---|---|---|---|---|---|---|---|
| No. 59 | ♂ | 80 | 53 | 16 | 11 | 18 | 20 |
| " 63 | ♀ | 93 | 56½ | 16 | 11 | 16 | 18½ |
| " 61 | ♂ | 91 | 55 | 18 | 13 | 17 | 25 |
| " 58 | ♂ | 82 | 57 | 17 | 9 | 17 | 16½ |
| " 57 | ♂ | 87 | 55 | 16 | 10 | 17½ | 23 |
| " 76 | ♂ | 95 | 56 | 18 | 9½ | 18¾ | 18 |
| " 7 | ♂ | 89 | 54½ | 17¼ | 9½ | 17½ | 21 |
| " 15 | ♂ | 84 | 50½ | 16 | 9¼ | 17 | 17 |

*Lobodon carcinophagus*, far more than any other Antarctic seal, presents in its skin the scars and wounds which have drawn the attention of naturalists for many years. They have proved a fertile source of discussion and speculation, not only on account of their scientific interest, but because the commercial value of such scarred skins is much reduced. It is certainly true that the greater number of *Lobodon* skins taken in the Antarctic ice are damaged by long rents. These may present themselves as freshly inflicted wounds, deep and gaping through skin and blubber to the flesh, or as shining white scars formed by the healing of such wounds.

"Half the pack seals are worthless from scarring. Scars frequently running parallel up to twelve inches long and about one inch apart, chiefly on the sides and lower parts of the body." Thus Mr. Bull, whose interest in the voyage of the 'Antarctic' was largely a commercial one. He suggests, further, that the Iceland ground sharks may have some Antarctic counterpart in an animal with similar habits, and were it not that the abundance of *Orca gladiator* in the South makes such a surmise hardly necessary, the suggestion would be a good one.

Captain Jensen, too, whose interests were also to some extent commercial, has remarked upon the fact, saying that many of the "Grey Seals" taken were more or less cut up with scars and wounds in the skin.

Captain Kristensen thinks that the wounds are made by a sword-bearing animal. It is well, therefore, in the light of these suggestions to examine carefully the nature of the wounds that are so commonly found on the Antarctic seals, not one species of the whole number being altogether free, though *Lobodon* appears to be more subject to them than any other.

*Leptonychotes* I have myself seen on one or two rare occasions with large, gaping wounds upon the side, although it is, on the whole, wonderfully free from them. Amongst thirty skins of *Leptonychotes* in the 'Discovery's' collection not one can show the typical scars, though many of the males can of course show fighting scars, the short and

shallow rents which are made in the rutting months by other males. These cannot be mistaken for the long scars at present under discussion.

*Ommatophoca* males show abundant fighting scars, but I am not aware of any skin of this species which shows the characteristic rents, though the scarcity of skins almost removes this seal from the discussion.

*Stenorhinchus leptonyx*, one might imagine, would be free of these wounds if speed and strength can avoid them, yet it has been reported with the typical open wounds, the specimen being a young one. The fact remains, however, that whereas in other seals the scars occur but rarely, in *Lobodon* one may say they are the rule. Out of twenty-four skins of *Lobodon* in the 'Discovery' collection no less than thirteen have the marks of these scars and wounds upon them, quite distinct in every case from the fighting scars. The small, short, and often abundant fighting scars are found on the males alone; they are more abundant in nearly every case about the head and neck, and of this, skins 7, 8, and 22 of our collection afford good examples, though in the male Weddell's Seal they are often universal, with a special abundance round the genital orifice. The more serious scars and wounds, on the other hand—great rents measuring from 12 to 17 and 20 inches long, arranged in parallel rows from 2 to 2¼ and 2½ inches apart from one another—these are, of course, not made by seals' teeth.

In almost every case they are on the sides of the animal or on the abdomen, and appear to have been inflicted from below. There is a close similarity in them all that at once puts out of court the suggestion of damage done by ice movements. One can imagine a seal being crushed between moving ice floes, or losing a flipper, or its life, but one cannot see how ice can tear the skin like a horse-rake, leaving ten or twelve tooth marks in a parallel series, each equi-distant, more or less, and up to 18 inches in length (*see* fig. 26, p. 38). Such wounds can only have been made by the Killer Whale, the *Orca gladiator*—the predacious dolphin of whose powers Eschricht gives us some idea when he says that in the stomach of one of the Northern Killers were found the remains of no less than thirteen porpoises and fourteen seals.

This wolf of the seas is extraordinarily abundant in the Antarctic; we have seen it constantly in herds of a score or more together hunting along the edges of the ice where seals and penguins may be found. On a few occasions McMurdo Sound has been full of them, their high curved fins appearing everywhere, and on one occasion there must have been a hundred in a herd. These powerful beasts, about 15 to 20 feet in length, are almost, if not quite, identical with the Northern form. They travel far to North and South, and were with us in S. lat. 30° as well as in 78°. They seem to be resident in the South so far as open water will allow, for they appear as the ice breaks up, and are last seen as the water freezes over. Ever on the hunt for seals and penguins, the damage that they do is written plain on *Lobodon's* skin, and I think it is impossible to doubt its evidence.*

* See also F. D. Bennett, "Whaling Voyage round the Globe," 1840. Vol. ii., p. 239.

Such skulls of the Northern *Orca* as I have been able to examine present an array of teeth which well agree with their inscriptions. The distance dividing the conical crowns varies from 1 to 2½ inches. These measurements as nearly as possible agree with many of the scars. Take, for example, such scars as are figured below from skin No. 6 in our collection, showing not only where the teeth of the upper and lower jaws pierced the skin, but where the skin eventually gave way and allowed the victim to escape (fig. 26, p. 38). The spacing of the teeth in this case must have been about an inch, and the length of jaw which inflicted the wounds, about 21 inches.

## OMMATOPHOCA ROSSI.

### *Ross' Seal.*

*Ommatophoca rossi*, Gray, Zool. Ereb. and Terr. (1844), pp. 7–8, Pls. VII., VIII.; Barrett Hamilton, Rep. 'South. Cross' Coll. (1902), p. 46, *ibique citata*; Brown, Mossman, and Pirie, Voy. 'Scotia' (1902), pp. 320, 321, 327, 350, 361.

List of Material in 'Discovery' Collection.

No. 1, ♂, ad. skin and skull. Jan. 7, 1902. 68° S. lat., 175° E. long. Pack ice, Ross Sea.
No. 46, ♂, ad. skin and skull. Jan. 8, 1902. 70° S. lat., 173° E. long. Pack ice, Ross Sea.
No. 14, ♀, ad. skin and skull. Jan. 6, 1902. 68° S. lat., 175° E. long. Pack ice, Ross Sea. (*Mounted for the B. M. Gallery by Rowland Ward.*)

List of Material in 'Morning' Collection.

No. 68, M. 26, ♂, ad. skin and skull. Jan. 1903. 69° S., 178° E. Pack ice, Ross Sea.
No. 67, M. 25, ♂, ad. skin and skull. Jan. 1903. 69° S., 178° E. Pack ice, Ross Sea.
No. 69, M. 28, ♂, ad. skin and skull. Jan. 1903. 69° S., 178° E. Pack ice, Ross Sea. In full moult.

*Ommatophoca* was first discovered by the British Expedition of 1840 under Sir James Ross, and the type specimen which was captured on January 8th in the pack ice to the north of Ross Sea (68° lat., 176° E. long.), is now in the British Museum (No. 324 A). It was described by Dr. J. E. Gray, and remained unique until, first the Belgian Expedition of 1898–99, and then the 'Southern Cross' of 1898–1900, brought home more examples and some notes upon its natural history.

Mr. Bruce's "Mottled Grey Seals" were almost certainly young adult Crab-eaters in the freshly moulted coat. The two species are not easily confounded, and so far Ross' Seal has never been discovered in numbers together, preferring, it would seem, always to live a solitary existence in the pack.

From Dr. Racovitza we have a description of this seal, of its voice in particular, and of its general appearance in the flesh, accompanied by a very excellent photograph which shows the peculiar habit it has of inflating the pharynx with air.

Six specimens of *Ommatophoca* were procured by our own expedition in the pack ice of Ross Sea, and on thirteen occasions it was seen by members of the 'Belgica' Expedition in the pack ice to the west of Graham's Land. This very

fairly represents the distribution of the seal as regards number. It has never been found in any abundance, but occurs generally in the pack ice, and almost always singly.

Its range extends over a wide area (40° W. lat. to 160° E. lat.) from the neighbourhood of Alexandra Land westwards to the pack ice of Ross Sea, and in rather increasing numbers towards the Balleny Islands.

In the 'Discovery' we procured two males and a female in our short passage of a week through the belt of ice pack, while Dr. Davidson, in the 'Morning,' who made the passage on two occasions, procured three more examples, all of which were males (figs. 27, 28, and 29, p. 44). It is strange how far more frequently males have been procured than females. Of the four specimens obtained by the 'Southern Cross' three were males.

A young Ross' Seal has quite recently been reported by the Argentine Expedition as having been captured on the shores of the South Orkney Islands. How young this specimen may be I do not yet know, but it is interesting that it should have occurred so near to land. No example has been found in the natal woolly coat, neither do we even know whether *Ommatophoca* is born in the usual woolly covering of seal infancy or whether this is shed *in utero.* Its breeding habits are wholly unknown, and though it is safe to conjecture that it produces its young about the same time as the other Antarctic seals, and in the open pack ice, it remains still for some expedition, wintering as did the 'Belgica' in the open pack, to prove it.

The new-born young of *Macrorhinus* are described as black; those of *Cystophora* are white, born in a woolly coat, which is very soon discarded. Analogy, therefore, does not help us to guess, though it will be a point of great interest to know, what is the appearance of the new-born young of *Ommatophoca.* The white colour of the young of *Cystophora* suggests, as Captain Barrett Hamilton says, that this species may have been a more strictly Polar animal; and one may perhaps expect the same colour also in the young of *Ommatophoca.*

There seems to be a far greater difference in the size of the male and female in *Cystophora* and *Macrorhinus* than in *Ommatophoca,* a number of whose dimensions are here given, taken from the animals in the flesh.

'Discovery' Collection.

| No. | Sex. | Colour of the chin and throat. | Tail tip to nose tip in inches. | Girth at the arm-pits in inches. | Girth at the umbilicus in inches. | Side to side diameter taken 12ins. from nose tip. | Side to side diameter taken 6ins. from nose tip. | Side to side diameter taken at the shoulders. | Side to side diameter taken 1 foot from tail tip. | Side to side diameter taken 2 feet from tail tip. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ♂ | Pale chin and throat. | 84 | 52 | 52 | 16 | 8 | 20½ | 10 | 16½ |
| 46 | ♂ | Pale chin and throat. | 93 | — | — | 13 | — | — | — | — |
| 14 | ♀ | Pale chin and throat. | 84 | 52 | 52 | 16 | 8 | 20½ | 10 | 16 |

'MORNING' COLLECTION.

*Measurements taken by Dr. Davidson.*

| No. | Sex. | Colour of the chin and throat. | Tail tip to nose tip in inches. | Greatest girth in inches. | Length of fore flipper in inches. | Breadth of fore flipper in inches. | Length of hind flipper in inches. | Spread of hind flipper in inches. |
|---|---|---|---|---|---|---|---|---|
| 25 | ♂ | Pale chin and throat. | 88 | 59 | 16 | 12 | 18 | 26 |
| 26 | ♂ | Blackish chin and throat. | 71 | 46 | 10½ | 8½ | 13½ | 22 |
| 28 | ♂ | Blackish chin and throat. | 78 | 50 | 14½ | 9½ | 15½ | 23 |

In No. 46 of the 'Discovery' collection the diameter was taken from side to side with callipers at every twelve inches of the animal's length. This gives the proportions of the animal in the flesh.

Diameter from side to side :—

At a point 1 ft. from tip of nose 13 ins.
" 2 ft. " " 21 ins.
" 3 ft. " " 22½ ins.
" 4 ft. " " 20 ins.
" 5 ft. " " 18 ins.
Position of Penis.
At a point 6 ft. from tip of nose 12½ ins.
" 7 ft. " " 10 ins.

In the 'Discovery' series the only female is larger than two of the five males, but it must be noted also that whereas these males are young adults, the female is a very old one. It is unfortunate that the skins and skulls obtained by the 'Southern Cross' are unsexed and cannot be included in this comparison, and that the four skins brought home by the Belgian Expedition range only from 52 inches to 58 inches, obviously animals which were not full grown, and a most unfortunate series from which to estimate the average size of *Ommatophoca.*

The greatest length of any specimen that has come under my observation is 130½ inches, the skin of the animal mentioned by Mr. Bernacchi as being nearly eleven feet in length, in the flesh. This animal, almost certainly a male, was of a brownish hue, with a pale throat and chin. One other skin of the 'Southern Cross' collection, which measured 92 inches in length, was also certainly a male, and was of a blackish grey colour with a blackish chin and throat which faded gradually into the paler grey of the chest and abdomen. If these two skins are included in my list of measurements, the males on the whole may be taken to be distinctly larger than the females, and in size equal to that of Weddell's Seal and exceeding that of the average Crab-eater.

With a capability of reaching close on 11 feet, it is the more remarkable that out of thirteen specimens none bigger than 4 feet 10 inches should have been brought home by the Belgian Expedition. In shape Ross' Seal is quite distinct from the other Antarctic seals, as can be well seen in the photographs which have been published,

not only by Dr. Racovitza, but also in the 'Southern Cross' Report, and lastly in the present publication (*see* Figs. 27 and 28). It is well adapted to a marine life, and, in consequence, ill adapted for progression on land and ice. On the few occasions on which we saw it in the pack ice, it made no effort to escape. Consequently, we can say nothing as to its methods of progression. It has, as it lies on an ice floe, a most peculiar pug-like expression of countenance. It was in each case excessively fat, and its head was withdrawn into the circular folds or rolls of heavily blubbered skin on the neck to such an extent as almost to disappear from sight. The eyes are not large, and the mouth is small for the size of the animal compared with the mouths of other Antarctic seals. This one would expect from the decadence of the post-canine teeth. The prominence of the forehead and throat in Fig. 28 is as characteristic as it is peculiar, and results solely from the withdrawal of the head upon the neck.

We had not the good fortune to see or hear this seal perform vocally, but having constantly heard Weddell's Seals produce a variety of musical noises both laryngeal and œsophageal, we could easily appreciate the excellent description given by Dr. Racovitza of *Ommatophoca* :—" Ce phoque possède aussi une aptitude curieuse qui le distingue de ses congénères. Sa voix est beaucoup plus compliquée et les sons qu'il émet plus variés que ceux des autres phoques. Il peut gonfler son larynx et en outre son énorme voile de palais, de façon à constituer deux caisses de résonnance, deux poches contenant grande provision d'air. Cela lui permet d'exécuter des trilles et arpèges aussi sonores que bizarres. Lorsqu'on l'irrite, il commence par gonfler son larynx en rabattant la tête en arrière. Il produit alors, la gueule ouverte, et son voile de palais distendu apparaissant comme une grosse boule rouge, un roucoulement semblable à celui d'une tourterelle enrouée. Puis il ferme la gueule et émet un gloussement de poule effrayée. Il expulse finalement avec violence, par les narines, sa provision d'air, et cela produit un reniflement comparable à celui que fait un cheval qui s'ébroue."

The flippers of Ross' Seal are large and well formed for swimming. The nails are generally to be found, if carefully searched for, on each digit of both fore and hind limbs, but they are all rudimentary, and wholly functionless. The fore flippers are webbed to the extremities of each digit, and when spread the limb forms a most efficient paddle. The hind limbs have also a very extensive spread, the first and fifth digits, in particular, being flattened out and lengthened, form lobes which have a strong similarity to those of *Macrorhinus* ; they are also, as in that seal, completely covered with hair. The length of the first and fifth digits of the hind limb, compared with the third or centre, is as 15 and 16 inches to 9 inches.

The food of *Ommatophoca* consists of cephalopods. The beaks of cuttle-fish have on more than one occasion been found in the stomach contents of this seal, and the following passage occurs in a report on the Argentine Antarctic Station by Mr. Rudmose Brown, of the Scottish Expedition (*The Scottish Geographical Magazine* for April, 1905) :—" From the number of cuttle-fish beaks found in seals' stomachs, the Scottish Expedition had the strongest evidence of the existence of a large cuttle-fish in

Fig. 27. Ross' Seal, adult.

Fig. 28. Ross' Seal, adult.

Fig. 29. Ross' Seal, adult.

*To face p.* 44.

South Orkney waters, so that the capture by the Argentines of one with a body over 6 feet long is of special interest."

Mr. Hanson on January 21st, 1899, notes in his diary that the stomach contents in one case consisted of seaweed, and that "in the bowels he had an immense number of worms." On January 24th in another case he mentions "Octopus and vegetable stuff;" and on February 3rd, "the stomach was quite full of food, consisting solely of octopus." For the "worms," which were parasitic, we ourselves can vouch, for in each of the three specimens that we obtained there was quite an enormous number of nematodes in the stomach and tape-worms in the gut; but of food remains, absolutely none. Ross' Seal lives mainly on soft-bodied cephalopods, and to this end has developed the incisors and canines into needle-pointed recurved hooks of great delicacy, and has allowed its post-canine teeth to degenerate. The gums presumably can manipulate such food as well as could molar teeth, and so we find that in some cases, although developed, the post-canines are small and insignificant, whereas in others they are loose and useless and occasionally absent altogether. To such a marked degree is this degeneration of the cheek teeth progressive that it is rare to find two skulls to which the same formula applies.

The discrepancies brought to light by Captain Barrett Hamilton in the series of the 'Southern Cross' collection have been fully maintained by the six additional skulls of our own. In this series of six skulls there are no less than five variations, and it may be of interest here briefly to sum up the position by placing these and several others for comparison together, though the question of variation in the dentition of the seals generally is more fully discussed below (see p. 46).

British Museum Series of Ommatophoca Skulls.

| | | | |
|---|---|---|---|
| No. 324 b. Ross' Expedition ... ... ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{6-6}{6-6}$ |
| No. 43.11.25.4 Ross' Expedition, No. 324A ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{5-5}$ |
| No. 3 of the 'Southern Cross' Collection, 1.1.4.12 ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{6-6}{5-5}$ |
| No. 1 of the 'Southern Cross' Collection, 1.1.4.13 ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{\text{absent}}{\text{absent}}$ |
| No. (Not labelled) ... ... ... ... ... ... | I $\frac{3-2}{3-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{6-4}$ |

'Discovery' and 'Morning' Series.

| | | | |
|---|---|---|---|
| No. 1. ♂ 'Discovery' ... ... ... ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{6-6}{5-5}$ |
| No. 14. ♀ 'Discovery' ... ... ... ... ... ... | I $\frac{3-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{6-6}$ |
| No. 46. ♂ 'Discovery' ... ... ... ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{4-4}$ |
| No. 67. ♂ 'Morning' ... ... ... ... ... ... | I $\frac{3-3}{2-3}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{(?)-6}$ |
| No. 68. ♂ 'Morning' ... ... ... ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{6-6}$ |
| No. 69. ♂ 'Morning' ... ... ... ... ... ... | I $\frac{2-2}{2-2}$ | C $\frac{1-1}{1-1}$ | PC $\frac{5-5}{5-5}$ |

In our own series the teeth of skull No. 1 are exceptionally strong and well-developed throughout, quite regular, and firmly rooted. The same remarks apply also to the teeth of skull No. 14, but for the presence of a small additional incisor, and to those of No. 46. The incisor teeth of No. 25, however, are most unusual. They occur in two tiers, of which the outer four are the larger, and the inner four minute. In skull No. 26 the teeth are all well developed but not well rooted. The alveoli are shallow, and just outside and behind the first premolar on each side of the lower jaw is what appears to be a persistent milk tooth. In skull No. 28 precisely the same apparent persistence of a milk tooth is to be seen in a similar position on each side of the upper jaw.

In the fresh-killed animal it is quite a common thing to find all the cheek teeth loose, and when the skull is cleaned, they will be found in some cases to have no bony socket at all, being merely held in the fleshy gum ready to drop out sooner or later and leave no trace of their existence.*

*Ommatophoca* has apparently the same range and distribution as *Lobodon*, and no doubt if both were dependent on the same food, there would be some struggle between them for subsistence. But seeing that *Lobodon* lives on crustaceans, and *Ommatophoca* mainly on cuttle-fish, and possibly some vegetable matter, there is obviously room for both, and it is not easy to see why in numbers *Lobodon* should be so very far ahead.

If we consider the position which *Ommatophoca* has been given in the later classifications of the seals, we may doubt, I think, with some reason whether it has really as much in common with the *Stenorhinchinæ* as has been claimed for it, and whether it has not closer affinities, notwithstanding the number of its incisors, with the *Cystophorhinæ* than with any of the *Stenorhinchinæ.*

In all the seals, with but very few exceptions, the variation in the dentition is so excessive, that one is led to doubt the advisability of laying so much importance on this one feature. When one finds, for example, in the *Phocinæ*, grouped mainly upon the number of their incisors, first an example of *Phoca vitulina* with I. $\frac{3-3}{3-2}$ as a variation of I. $\frac{3-3}{2-2}$; then an example of *Phoca fœtida* with I. $\frac{2-2}{1-1}$ as a variation of I. $\frac{3-3}{2-2}$; then, too, in the *Stenorhinchinæ*, two examples of *Monachus albiventer*, one with I. $\frac{3-3}{2-2}$, the other with I. $\frac{4-2}{2-2}$, as variations of I. $\frac{2-2}{2-2}$, and an example of *Lobodon* with I. $\frac{2-2}{2-1}$ as a variation of I. $\frac{2-2}{2-2}$, and no less than four variations

* My attention has been drawn by Prof. F. Jeffrey Bell to the following discrepant statements concerning vestigial teeth in Whales. Prof. M. Weber (Die Saugetiere, 1904, p. 578) says of the Physeterinæ :—" Zahne des Oberkiefers rudimentar, brechen nicht durch"; but Bennett (Whaling Voy. Round the Globe, Vol. II., 1840, p. 163) says:—" The upper jaw is not altogether toothless, as usually described. On the contrary, it has on either side a short row of teeth, which, for the most part, are placed more interior than the depressions which receive the teeth of the lower jaw; though they sometimes, also, occupy the bottom of those cavities. Their entire length is three inches; they are curved backwards, and elevated about half an inch above the soft parts, in which they are deeply imbedded, having only a slight attachment to the maxillary bone. In two instances, I have found their number to be eight on each side. They exist in both sexes of the Sperm Whale; and although visible externally only in the adult, they may be seen in the young animal upon removing the soft parts from the interior of the jaw."

from the normal number and arrangement of incisors in *Ommatophoca*, I think that, however satisfactorily a seal may fall into a certain sub-family in this respect, one is bound to ask first whether the number of incisors is a point of such great importance as is thus implied, and secondly, whether a special taste in foodstuffs may not have led to something like a reversion in the number as well as in the character of the teeth. Presumably, the less differentiated types of seal have the greater number of incisors, and so presumably the *Cystophorinæ*, having reduced them to a minimum, have departed farthest in this respect from the ancestral type. But having done so, it would be as easy at any rate, if not easier, for a seal to revert again to the greater number of incisors than to make a still greater reduction as in the *Cystophorinæ*. This seems to me to have been the case with *Ommatophoca*, and quite a considerable number of points can be adduced in which it shows close affinities with *Cystophora* and *Macrorhinus*, far more than can be adduced to connect it with the *Stenorhinchinæ*.

For example, if we examine the post-canine series we find in *Ommatophoca* a strong tendency to reduce their number, giving the following abundant variations:—
P.C. $\frac{6-6}{6-6}$, P.C. $\frac{5-5}{5-5}$, P.C. $\frac{6-6}{5-5}$, P.C. $\frac{5-5}{6-4}$, P.C. $\frac{0-0}{0-0}$, P.C. $\frac{5-5}{6-6}$, P.C. $\frac{5-5}{4-4}$
In *Machrorhinus*, also a strong tendency to reduce, P.C. $\frac{5-5}{5-5}$, P.C. $\frac{4-4}{5-4}$, P.C. $\frac{3-3}{5-4}$, P.C. $\frac{5-5}{4-4}$, and almost the same extraordinary variability in their number, pointing to a similar functional worthlessness such as we have seen holds good in *Ommatophoca*, while in *Cystophora*, though there is no tendency to reduce the number of post-canines, the reason is probably to be found in the fact that its food consists not wholly of Cephalopods, but also to a considerable extent of some food which necessitates a more useful set of molars for purposes of mastication.

There is therefore upon consideration of the post-canine teeth, good reason for thinking *Ommatophoca* to be more closely related to the *Cystophorinæ* than to the *Stenorhinchinæ*, not a member of which shows any tendency whatever to vary from the normal type P.C. $\frac{5-5}{5-5}$, save *Leptonychotes*, in which the only aberrant examples discoverable in about forty skulls, have P.C. $\frac{6-6}{5-5}$, and P.C. $\frac{6-5}{5-5}$, showing, if anything, not a tendency to reduce the cheek teeth, as in *Ommatophoca*, but to multiply them. Both in the incisors and in the cheek teeth therefore the affinity of *Ommatophoca* to the *Cystophorinæ* seems to be upheld.

If we now turn to other points, and examine the skulls of the species under consideration, we find quite as many and as important points in which *Ommatophoca* resembles *Cystophora* and *Macrorhinus*, as we find points in which it resembles any members of the *Stenorhinchinæ*. For example, to quote from Sir William Turner, the skull of *Ommatophoca* approaches that of *Cystophora* not only in the vertical inclina-

tion of the anterior nares, but in the relation of the anterior nares to the infra-orbital foramen, in the width of the orbits and interzygomatic regions; and in the small proportion of the ascending parts of the premaxillæ, which leave a large part of the anterior nares to be bounded by the superior maxilla. To these I would add that in *Macrorhinus* the premaxillæ make no effort to reach the nasal bones at all and leave the whole of the anterior nares to be bounded by the superior maxilla; in this respect very widely differing from the form of the same bones in the *Stenorhinchinæ.*

It is of course true, as Captain Barrett Hamilton has pointed out, that in some respects the skulls of *Ommatophoca* and *Cystophora* differ. He allows, however, that the few characters to which he draws attention do not bring *Ommatophoca* any nearer to the *Stenorhinchinæ,* and this is just the point I wish to urge. The resemblance of the skull of *Ommatophoca* to that of *Macrorhinus* is seen to be very marked when only immature skulls of the latter are taken for comparison, a point which it is well to bear in mind when using such highly specialised animals for comparison as the adult Sea Elephant. It is exactly as one would expect that *Ommatophoca,* in which no very striking peculiarities have been developed, should find its closest resemblance in the young and immature skulls of *Macrorhinus,* which represent far better than the adults the more primitive type from which both of these seals as well as *Cystophora* have probably sprung. There appears, moreover, to be some reason for believing that *Ommatophoca* approaches *Macrorhinus* and *Cystophora* in the relative size of the sexes, at any rate to a greater extent than do the other members of the *Stenorhinchinæ;* and the evidence of all the fighting scars upon the adult males of *Ommatophoca* inflicted as they are, solely on the head and neck, as in the *Cystophorinæ,* and never on the body, as in the *Stenorhinchinæ,* affords strong support to the assumption that they fight standing up to one another on their fore limbs, as do the *Cystophorinæ;* both *Ommatophoca* and the *Cystophorinæ* approaching on this point far more closely to the *Otariidæ* than do any of the *Stenorhinchinæ.*

In food also, as one would expect from the form of the teeth, *Ommatophoca* agrees with the *Cystophorinæ,* both members of which are said to live mainly upon cephalopods. There is also in the character of the hair of *Ommatophoca* a certain similarity with that of *Macrorhinus,* both having short, flat, broad and decidedly coarser hair than occurs in any of the *Stenorhinchinæ.*

There is, as I have said, a strong general similarity in the form of the hind flippers of these two seals, a similarity which is not shared by other members of the *Stenorhinchinæ,* and the extremely rudimentary nature of the claws upon the hind limbs is characteristic of both, as also of *Monachus,* and different from those of *Stenorhinchus, Leptonychotes,* and *Lobodon,* in all of which the claws are well developed.

In the fore limbs, however, *Ommatophoca* stands apart with claws as rudimentary as those upon its hind limb, whereas the claws of the fore limb in *Macrorhinus* and *Monachus* and of both limbs in *Cystophora* and *Halichærus* are exceptionally well developed.

Nor is there in *Macrorhinus* any marked development of spots or splashes, and in this *Ommatophoca* conforms to it rather than to the characteristically spotted seals with which it is at present grouped. Nevertheless, it would not be surprising to find that the young of *Ommatophoca* was spotted as is the young of *Cystophora*; particularly as a tendency to spotting is occasionally found in *Macrorhinus*. In a very great number of ways, therefore, it would appear that *Ommatophoca* has really closer affinities with the *Cystophorinæ* than with the *Stenorhinchinæ*, notwithstanding the apparently decisive judgment given by its dental formula. This I believe to be perhaps of less real value than it at first seems to be, owing to the extraordinary amount of variation to which even the number of the incisors is subject in every group of seals.* Hardly a species but shows by these variations that no hard-and-fast law binds them, and the fact obviously means that the teeth throughout the family are undergoing rapid changes. In some, as in *Ommatophoca*, the cheek teeth are on the point of disappearing altogether, and it is therefore less surprising to find that the canines and incisors are becoming of greater importance to this animal. Is there any great difficulty in believing that in such a case, even if the incisors had once been reduced to $\frac{2-2}{1-1}$, they should again revert to $\frac{2-2}{2-2}$, or, indeed, as in one case has actually happened, that the reversion should go even farther and produce three incisors on one side in both upper and lower jaws? This example alone is sufficient to prove that there is no insurmountable difficulty preventing the multiplication of incisor teeth. I cannot help thinking that either the young of *Ommatophoca*, or a more abundant series of skulls than is at present at hand for examination, will tend to show that this seal is misplaced among the *Stenorhinchinæ*.

In the eleven skins of this animal that have now come under my notice there appear to be two definite varieties of colour apart from changes which can be attributed to age or moult. Both are identical up to a certain point, being blackish grey in general tone, when freshly moulted, darkening considerably towards the middle line of the back and becoming almost whitish on the under surface, but with no definite line of demarcation between the two. Running backwards, however, from the sides of the neck and shoulder are a number of narrow streaks and lines, pale and indistinct, but quite constant, and marking the whole of the lateral aspect of the animal almost to the tail. Many of these pale lines are unbroken for several inches in the region of the shoulder, but towards the middle of the animal's length become broken and irregular. Towards the hinder flippers and the tail the line of separation between the darker dorsal and the paler ventral grey becomes more definite, and this demarcation line extends on to the hind limb, sometimes between the fourth and fifth digits and sometimes dividing the flipper into equal halves, one dark and the other pale.

* *See* Bateson, "Materials for the Study of Variation" (1894), pp. 235–243, where a number of other examples illustrating the same point will be found, and where the variation in each case has been treated in detail.

The tail is almost black, with a fringe of pale hairs round the edge, and is of a more conical shape than the tail in other members of the *Stenorhinchinæ.*

All this is true for freshly moulted skins. But in two of the six skins in our collection, and also in two of the 'Southern Cross' collection, the chin and lower lip are black instead of white, and this blackness extends backwards over the throat to fade away upon the breast and belly. The line of demarcation between this dark band upon the throat and the pale whitish-grey of the sides of the head and neck, cheek, upper lip and eyebrows, is well defined. In four skins of the six in our collection and in two of the 'Southern Cross' collection, however, the chin and throat instead of being black are white, and this is the colouring of the type specimen in the British Museum. The difference has nothing to do either with sex, age, or locality so far as can at present be seen, and must be cited merely as an instance of individual variation.

The moult in this seal takes place in January, and in that month the animal may be found in a rusty brownish-grey coat, of which the hairs are loose. When this is shed the blackish-grey coat, which I have just described, appears first as a very meagre covering. It seems that this seal prefers to starve for a week or two rather than enter water whilst the moult proceeds. Hanson, in his diary notes, describes how he found one moulting in the pack: "He was shedding his hair, and to all appearance he had been lying several days in the same place where we found him, as there was a lot of hair and excrement scattered round about on the ice, and on opening the stomach it was found to be quite empty. . . . . There was hardly an inch thick of blubber on the skin." Skin No. 28 of our collection is in full moult, and shows well the difference between the colour of the old and new coat.

The coat of *Ommatophoca* when examined closely is seen to consist of two different sets of hair. The most abundant of these are short and blackish to the naked eye, while longer white hairs can be seen sparsely but generally intermixed. The white hairs are on an average about one-third longer than the shorter and darker hairs. All are flattened, stiff and straight, with a strong resemblance to the hairs of *Macrorhinus* and *Cystophora.*

Several of the skins in the 'Discovery's' collection are badly scarred, but in every case they are the scars which result from the fights between the males in the rutting season. They are particularly well seen in skins No. 1 and 46, disposed, as already noted, almost solely, about the head and neck. In no case have I seen scars on Ross' Seal which might be attributed to the Killer Whale, a fact which may be connected with the more perfect development of this seal for a marine life, with its torpedo shape and comparatively large flippers indicating a power and speed in water not seen in other species.

## MACRORHINUS LEONINUS.

*The Sea Elephant.*

*Phoca leonina*, Linn., Syst. Nat. I. (1758), p. 38.

*Macrorhinus leoninus*, Allen, Hist. N. Amer. Pinnipeds (1880), p. 466, *ibique citata;* K. A. Andersson, Wiss. Ergeb. der Schwed. Südpolar-Exped., Bd. V. 2 (1905), pp. 16–18 ; Brown, Mossman and Pirie, Voy. 'Scotia' (1906), pp. 203, 261, 327.

Material in the 'Discovery' Collection.

No. 26, ♀, Young. Skin and skull. November 22, 1901. Macquarie Island.
No. 43, ♂, Young. Skin and skull. November 22, 1901. Macquarie Island.
No 37, ♂, ad. Skin and skull and complete skeleton. January, 1904. Cape Royds, South Victoria Land.

The colouring of the soft parts is as follows :—Iris, dark brown ; mouth and tongue, pale pink.

On the occasion of our landing on the Macquarie Islands we saw something of the Sea Elephants that are to be found there, a scanty remnant of a much persecuted race of animals.

The landing on the east side, in the bay known as Fisherman's Cove, is not altogether easy, by reason of the swell which rolls in from the open ocean, but this diminishes as one enters the belt of kelp which liberally fringes the shore.

A short way up from the beach are a few whalers' or sealers' huts; the flat part of the coast-line, extending from a quarter to half a mile, between the water's edge and the foot of the hills, is little better than a bog, stony in some places, covered with tussac grass in others, and wet everywhere.

Beside the huts was abundant evidence of the nature of the work undertaken by those who had inhabited them. Not only had Sea Elephants been boiled down for oil, but penguins also, and *Aptenodytes longirostris* had evidently come in for an undue share of attention, as the heaps of their discarded bones attested.

How near to extinction the Sea Elephant has been in these islands it is hard to say, but since 1880, when Professor Scott of Dunedin visited the island and found the Fur Seal quite extinct, shore parties are said to have been constantly boiling down both penguins and Sea Elephants, and 20 tons of Elephant oil were taken by five sealers a few years before our own visit to the island. In South Georgia, even so long ago as 1823, Weddell reported the Sea Elephant to be nearly extinct, no less than 20,000 tons of Elephant oil having been shipped to the London market alone. At one time (1802), we are told that 600 Sea Elephants were obtained in ten weeks between March and May, at King's Island, in the Bass Straits.

That seals of any kind should be still remaining is now a matter for wonder, and we were surprised to find in our short visit that there were really quite a considerable number of young Sea Elephants on the shore, and more, no doubt, than we saw, for

they were to be found in twos and threes asleep amid the clumps of tussac grass (*Dactylis*), and quite invisible until we came upon them, as much to their surprise as ours. Those that we saw here had come on land to change their winter coats, November being the month when they regularly leave the water for the purpose. After this, it is said, the calves are born, and the mating season begins in February. The males are then very thin by reason of their long abstinence from food during the time they have remained on shore.

It is said that the Sea Elephant rarely goes far from land, but it is hard to believe that this is the case, since we obtained a half-grown male in South Victoria Land (47° 50′ S. lat.), 1,000 miles or more from the nearest spot at which the animal has been known to breed ; and a second example is lately reported to have been seen in the South Orkneys by the Scottish Expedition.*

The habit they have of suddenly rearing their massive heads, with a loud, inspiratory roar and, in the male, inflated nostrils, showing the while a wide, pink cavern of a mouth and formidable canines, has before now been well described.

In none of the animals that we saw in the Macquarie Islands did the total length exceed 8 feet. A full-grown female is said to reach a length of 10 feet. We met with none of the enormous males whose length has been known to reach as much as 22 feet in all, nor did the proboscis in any of the young males with which we came in contact attract either comment or attention ; indeed, it was hardly noticeable, though a slight suggestion of its presence may be seen in the accompanying photograph, which shows the somewhat pointed shape of the nose of a young male, in which the proboscis is but to a slight degree developed (fig. 30, p. 52).

We saw, perhaps, a score or more in half a mile of the foreshore, some of which were asleep quite close to the kelp-lined beach, others some distance from it, even up the hillside amid the tussac grass. There were also large rookeries of penguins, both of the King (*Aptenodytes longirostris*) and of the Royal (*Catarrhactes Schlegeli*), both of which were breeding at the time. Though in close proximity, these birds and the Sea Elephants showed a total disregard of one another's presence, the latter being found asleep quite near the penguins in the muddiest of pools.

That the animals will use their jaws in self-defence when startled we proved by presenting a stick to the open mouth that sometimes confronted us in a startling manner as we made our way up some steep and grass-covered bank. The powerful animal would wrench it from our hands with so much vigour that we were careful to avoid a closer contact. Nevertheless, when on shore, their movements are exceedingly clumsy and their progress slow. A rate of a mile an hour would be a generous estimate when the animal is in a hurry to be away. The movement is best described as an ungainly "lope."

In the water they are at once at home. When brought to bay on land, a thing which is easily accomplished by the simple means of treading on some portion of the

* R. N. Rudmose Brown, The Scott. Geog. Mag. for April, 1905, p. 207.

Fig. 30. Young Male Sea Elephant, in the Macquarie Islands.

To face p. 52.

tail flippers, the animal swings round the hinder portion of its body and shows a threatening front with its open mouth. The motion is very characteristic; both ends are off the ground at the same moment, the hind flippers and tail swinging high into the air, while the head and neck are reared up, and the animal edges itself into a frontal position with the help of its fore limbs and a kind of backward shuffle.

The Macquarie Islands have long been known as a stronghold of this seal, but it has from time to time been reported as equally abundant in the Kerguelen, Marion, Heard, and Crozet Islands. It is said not to come so far north as the Campbell and Auckland Islands in the direction of New Zealand, although in other directions it has been taken at Tristan da Cunha, Juan Fernandez, the Falkland Islands, New Georgia and Inaccessible Islands; also from the Cape of Good Hope (Bartlett) and the "Antarctic Seas." It is therefore a seal of wide distribution, occurring abundantly in the South Indian and South Pacific Oceans, and wandering as much to the north as to the south.

For a discussion of the rights to specific distinction of the Californian species of *Macrorhinus* I must refer my readers to Desmarest (Mammalogie, pp. 239–240), Scammon (The Marine Mammals of the N.W. Coast of N. America, 1874), Allen (History of N. American Pinnipeds, p. 466), and Lydekker (Roy. Nat. Hist., Vol. II., p. 147).

After more than two years in the Antarctic ice without seeing any but the four well-recognised Antarctic species of seal, it was something of a surprise to meet with a Sea Elephant in McMurdo Sound. While encamped at Cape Royds (77° 40′ S. lat.) on the outskirts of the penguin rookery which has there established itself, our attention was arrested by the sight of a large yellowish seal, with a bulk and colour and general appearance that in no way suggested any of the common forms we were accustomed to. It lay on the black sandy beach not five yards from the water's edge, and as we came in sight raised its head and shoulders well on its fore limbs in a way that no Weddell Seal, Crab-eater, Ross or Leopard Seal could imitate. In every way, in bulk, in colour, and in attitude it reminded us of the Macquarie Elephants; it had also the same characteristic way of changing front. It was nevertheless hard to believe that a Sea Elephant, an animal that has become so rare now even in its own proper habitat, should have wandered thus far against the prevailing winds and ocean currents.

Having no means of capturing the animal, we made haste to leave him and return to camp, seeing that he became uneasy at the sight of us and evidently thought of taking to the water. On our return we were still twenty yards away when he awoke and raised himself well up on the fore limbs so that his broad blunt muzzle faced us. The nostrils were then conspicuously in front of and not on the top of the snout as in the other Antarctic seals. More than ever now in his alarm were the characteristics of *Macrorhinus* evident—the bulky forequarters, the massive head and neck, the free use he made of the fore flippers which bent out at the metacarpus almost like the

fore limbs of the *Otariidæ,* the large watery eyes and gaping mouth, and, above all, the disproportionately rapid tailing off of the hinder parts.

As we approached he began to edge towards the water, and had even entered it before we killed him. To haul such an animal up on the beach was no light task, for being a half-grown male his weight was probably half a ton or more. The mouth and tongue were fleshy pink, the latter short and thick with a deep-cut notch in the distal end. The eyeballs were very large with dark brown irides. All these parts were put on one side to be preserved, but though they lay quite close to us as we flenced the skin we were robbed of them by the Skua gulls. The whole skin moreover was afterwards buried in a mound of sand, yet the Skuas went to the trouble of uncovering it in part, and made bare patches on the back by pecking off the hair.

The boldness of this bird, combined with its strength of bill and claw, must never be forgotten by the collector in these regions, for it matters not what is left lying on the ice, they will soon have tried either to eat or to remove it. One views with small pleasure a Skua flying off to sea with a favourite knife-sheath or a belt; even coats are dragged about the ground, and bits of blubber freely taken from the hand.

The stomach of this Sea Elephant was empty, as also was the entire length of the intestines, which were very uniform in size and quite firmly contracted into a cord-like structure containing only a few small nematodes. Nevertheless, it was a heavily blubbered animal, to the extent of two or three inches under the skin, the whole body over. One cannot think, therefore, that it had been starving for any great length of time, and how it can have found its food on these icebound coasts, so different to those of its normal habitat, is difficult to see. From its dentition one would be led to consider that cephalopods must form the greater part of its subsistence.

The cheek teeth are in every way degenerate when compared with the well-developed canines and incisors, and this is a feature which may be expected more in an animal that lives on soft-bodied animals than in one that must either catch fish or crush the shells of molluscs. The small peg-top plaited crowns of its cheek teeth are in no sense adapted to such work. If a series of the skulls of this animal be examined, there will be found a variability in the number and permanence of the cheek teeth which reminds one strongly of the same feature in the dentition of *Ommatophoca.*

Of the five skulls of *Macrorhinus leoninus,* at present in the British Museum, no less than three are aberrant from what one must take as the normal dentition. This is as follows:—

$$\text{I.}\ \frac{2-2}{1-1},\quad \text{C.}\ \frac{1-1}{1-1},\quad \text{P.C.}\ \frac{5-5}{5-5}.$$

Flower gave the milk dentition as—

$$\text{I.}\ \frac{2-2}{1-1},\quad \text{C.}\ \frac{1-1}{1-1},\quad \text{P.C.}\ \frac{3-3}{3-3}.$$

In the British Museum series are three skulls with the normal number and arrangement of cheek teeth, but also the following, which is irregular in this respect :—

No. 334c. Ross Expedition. I. $\frac{2-2}{1-1}$, C. $\frac{1-1}{1-1}$, P.C. $\frac{4-4}{5-4}$.

To these may now be added :—

No. 26. Young ♀. Macquarie Island. 'Discovery' Collection.

$$\text{I. } \frac{2-2}{1-1}, \quad \text{C. } \frac{1-1}{1-1}, \quad \text{P.C. } \frac{3-3}{5-4}.$$

No. 37. Young ad. ♂. Cape Royds, McMurdo Sound. 'Discovery' Collection.

$$\text{I. } \frac{2-2}{1-1}, \quad \text{C. } \frac{1-1}{1-1}, \quad \text{P.M. } \frac{4-4}{4-4}, \quad \text{M. } \frac{1-1}{0-0}.$$

From such evidence of variability, I think it is fair to consider that the food is managed mainly by the canines and incisors, and that the post-canines are in a state of degeneracy, and will shortly disappear. There is little or no evidence of wear in the teeth of specimens 334a, 334c, and 334g of the B.M. collection. The specimen which we obtained in McMurdo Sound, No. 37, was considerably larger than any that we saw in the Macquarie Islands. It was, as I have said, a half-grown male. The following measurements were taken in the flesh immediately after death :—

| | |
|---|---|
| Total length from nose to tip of tail, along the curve of the back ... ... | 106 inches. |
| Girth under the fore flippers ... ... ... ... ... ... ... | 96 inches. |
| Girth at the position of the penis ... ... ... ... ... ... ... | 62 inches. |
| Girth at extremity of fore flippers as they lay along the sides ... ... ... | 96 inches. |

Its colour was a yellowish grey, darker dorsally, and pale ventrally—a good deal lighter altogether than that of the Macquarie specimens. As usual, there were no markings. The teeth were well developed, and showed no signs of wear. Nevertheless, the post-canine teeth of No. 94.11.17.1 (B. M. Coll.) show abundant evidence of long wear, this specimen having been taken from an old male.

Of the two examples obtained in the Macquarie Islands, No. 43 of the 'Discovery' Collection was a young male and No. 26 a young female. In neither were the teeth fully developed nor were the sutures of the skull united. In No. 43 the length from nose to tip of tail is 81 inches, a length some 17 inches greater than that of the female.

In colour both are of a uniformly dull buff or brownish-grey all over the upper parts, gradually paling on the sides to a lighter tone of the same colour underneath. The darkest shade is along the middle line of the back. The colour and tone of the fore and hind limbs are intermediate between the deeper part of the back and the lighter part of the belly. There are no spots or markings.

Terminating each digit in the fore limb is a long and narrow semi-cylindrical nail of a dark brown or blackish colour, measuring in the Antarctic example from $1\frac{1}{6}$ inch or 3 cm. in length, and extending half its length in each case beyond the digit itself. The depth of the interdigital space between the fourth and fifth is decidedly greater

than that between any two other digits, and the depth of the space between the first and second is rather less than that between second and third or third and fourth. The nails show no sign of wear and tear, but have the appearance of having grown in water, though with transverse ridges indicative of periodic fluctuations in their growth. That the limb in its functional use more closely approaches the type of limb found in the *Otariidæ* is most obvious when the living animal is observed, though in its general shape and outline in the dead animal it is more like the fore limb of the *Phocidæ*. The fore limb is still functional as a support on land to a far greater degree than it is in any member of the *Stenorhinchinæ*. Hair covers the palmar surface of the fore limbs to the extreme ends of the digits.

The hind limb, on the other hand, has everything in common with the hind limb of the more specialised of the *Phocidæ*. In it only the merest traces of vestigial nails can be discovered on the first and fifth digits, and no trace whatever of nails on the second, third, or fourth. The first digit is in a remarkable degree larger and wider than the fifth, though both are of a similar outline, the two limbs being well adapted to form a powerful fin or rudder when used in conjunction, either palm to palm in a vertical position, or outspread horizontally to form together an apparatus resembling the fluke of a whale. The three central digits, webbed almost to their tips, are long and tapering, but the third, which is the shortest, is about half as long as the first or fifth, and the second is slightly longer than the fourth.

That they are all well supplied with muscles which allow of adduction and abduction can be seen in the living animal, not only when under water but when lying on shore and in the act of stretching; the hind limbs are thus often extended to their widest limit when the free edge of the webbed limb, instead of being deeply concave in outline as it is when at rest, becomes straight or even somewhat convex.

Of facial bristles there are in the Antarctic specimen five rows on each side of the muzzle, and the bristles themselves are black and twisted. There are also eight conspicuous bristles in a clump over each eye. The hair is "flat, truncated, adpressed," as described by Gray, and resembles most nearly in character the hair of *Ommatophoca* and *Cystophora*.

In examples so young as this male, the characteristic proboscis, as I have already mentioned, is not yet fully developed, though three transverse creases in the skin of the nose are distinct, and indicate its extensibility. The profile outline of the head in such an animal when excited shows a more pointed physiognomy than would appear in the profile of the same animal when at rest, this being due to the partial inflation of the nasal sac; the external nares being thus forced out, open forwards and downwards, instead of upwards.

There is, I think, room for doubt as to whether *Macrorhinus* is really, as it has been considered, the most specialised form of the *Phocidæ*. *Macrorhinus* in all its movements is far more like one of the *Otariidæ* than is any other member of the true *Phocidæ*. The fact cannot but be noticed by anyone who has watched both classes of

seal in life, and if in other points also it can be shown to approach the *Otariidæ*, it must be considered not one of the most highly specialised of the *Phocidæ*, but one of the less. And from it, as a connecting form, we may possibly draw suggestions as to the affinities of other seals, some of which are without doubt closely connected with it.

From this point of view it will be seen that there are other characters in addition to its general family resemblance to the *Otariidæ*, which indicate a closer connection with them than can be argued for any other of the *Phocidæ*. For example :—While it is more at home in the water than on land, and its progression on land is exceedingly clumsy, yet the Sea Elephant spends almost, if not quite, as much time on shore as do the Sea-lions and Sea-bears. Almost precisely the same migrations are common to both, depending as they do upon similar annual necessities, such as the change of the winter coat, the birth of the young, the mating of the sexes, and so on. In all these points the Sea Elephant is far more of the habit of the *Otariidæ* than of the *Phocidæ*. Again the enormous difference in size between the male and the female is paralleled nowhere in the group of *Phocidæ*, though it is the rule in the *Otariidæ*. Whether this is connected in the same way with the polygamous habits that are seen in the *Otariidæ*, as opposed to the more indiscriminate methods of pairing which are seen in the *Phocidæ*, none of which appear to form so definite a harem, I cannot say, nor do I know of any account which supplies evidence upon this point.

The most specialised seals, *i.e.*, those that have departed most from their land-frequenting forebears, are those which have become least dependent upon land for any part of their existence.

No seal has yet taken to the production of its young in the water, though in some species, *Phoca vitulina*, for example, the young seal is said to be able to take to the water with safety at the moment of its birth, and there undoubtedly is a considerable range among the various species of seals in the length of time that must elapse between the birth of the young and its taking to the water. The shortest period must be a mark of more advanced specialisation in the *Phocidæ*, and in this respect *Macrorhinus* cannot be included in their number. The longest period, on the other hand, is certainly found in the *Otariidæ*, and *Macrorhinus* appears to conform to their habit. Thus taking first the *Phocidæ* :—

In *Lobodon carcinophagus*, the young takes to water in about three days, its woolly coat being rapidly shed at birth. (Racovitza.)

In *Leptonychotes weddelli*, the young takes to water in a month, commencing to shed its woolly coat at the end of the first two weeks, and completing the moult in four.

In *Phoca vitulina*, we have the young taking to water at birth, having shed its whitish yellow woolly coat *in utero* or on the day of its birth (according to Lloyd), or beginning to shed its white coat for a darker in three days (according to Macdonald).

In *Halichœrus grypus*, the young is born in a thick white woolly coat, which is shed in four weeks, and the young then takes to water. Suckling is said to last from three to ten weeks. (Hallgrimsson.)

In *Phoca groenlandica*, the young is born in a yellowish-white wool, which is shed a few weeks after birth. It takes to water in from fourteen to twenty days. (Brown.)

Whereas if the habits of the *Otariidæ* are examined, we find that :—

In *Arctocephalus forsteri* the young is suckled for 5 months, during which it completes a natal moult before it takes to water.

In *Arctocephalus hookeri*, the young is suckled for 5 months, and a natal moult is completed before it enters the water.

In *Callorhinus ursinus*, the young one is suckled for 3 months, and during the first month undergoes a natal moult before entering the water.

Now, in the case of *Macrorhinus*, we are told (Lydekker) that the young are left lying on the beach for as much as 6 or 7 weeks before entering the water, a period which is longer than in any other case concerning which evidence is forthcoming among the *Phocidæ*, and a period which is far more suggestive of the habits of the *Otariidæ*. We are told, on the other hand, by Professor Scott (in the "Trans. N.Z. Inst.," lxi., Nov., 1880) that the young are suckled only for three weeks, and that they are born in a black woolly coat, which is shed in a week, the coat which succeeds it being also black. These accounts appear to disagree, for the young would surely enter the water as soon as their mothers finally deserted them, but on this point Professor Scott is silent.

Furthermore, attention may be drawn to the period of gestation, which seems to be appreciably longer in the case of the eared seals than in the earless. More observations on this point are wanted, and it may be objected that such as we have are insufficient to argue from, but so far as they go they tend to place *Macrorhinus* at the Otarian end of the *Phocidæ* rather than, as Professor Flower would have us to do, as far as possible from them.

Periods of Gestation.

| | |
|---|---|
| *Phoca vitulina* ... ... ... ... ... ... | 9 months (Reeks). |
| *Phoca grœnlandica* ... ... ... ... ... | 9 months (Allen). |
| *Halichœrus grypus* ... ... ... ... ... | 9 months. |
| *Leptonychotes weddelli* ... ... ... ... ... | 10 months. |
| *Erignathus barbatus* ... ... ... ... ... | 10 to 11 months (Collett). |
| *Macrorhinus leoninus* ... ... ... ... ... | 11 months. |
| *Callorhinus ursinus* ... ... ... ... ... | 11 months, 20 days. |
| *Arctocephalus forsteri* ... ... ... ... ... | 11 to 12 months. |
| *Arctocephalus hookeri* ... ... ... ... ... | 12 months. |

With regard to the presence of an *under fur* in *Macrorhinus*, as noticed by Gray, I have not been able to draw any definite conclusion. Having had no opportunity of examining the new-born young, the hairs of young adult animals have been my only material for investigation, and I have been unable to see anything approaching the character of "under fur" in them. Should there be such a thing, it affords one more point of similarity between *Macrorhinus* and *Ommatophoca*, as well as between *Macrorhinus* and the *Otariidæ*.

The position of the external nares is a point which does not seem to be highly specialised in *Macrorhinus* for a life in the water. They are by no means so high on the nose, nor do they open upwards so much as in the more specialised *Phocidæ*, for

example, *Leptonychotes*, *Stenorhinchus*, or *Lobodon*. In this respect *Macrorhinus* is more like the *Otariidæ*, and so less differentiated from land mammals, and less specialised for a purely marine life.

In direct opposition to the above facts, which are drawn mainly from the life history of the animal, Professor Flower drew up a series of osteological characters which, in his opinion, showed that the Sea Elephant has developed seal-like characteristics more perfect than in any other form. These are briefly as follows :—

The shortness of the femur.
The want of development of the calcaneal process.
The articulation of the fifth metacarpal with the proximal row of carpal bones.
The development of claws on both feet (?).
The length of toes in hind limb, and extent of lobe behind the claws, for swimming purposes.
The ossification of all the phalanges, except the ungual, from three centres, instead of only from a proximal.
Its dentition presents an extreme form from other mammals, *Stenorhinchus* showing the perfection of the modification, and *Macrorhinus* the extreme form beyond it.
The form of the brain cavity, very wide posteriorly compared with its length, thus much modified from *Otariidæ* and land carnivora.

It is true, no doubt, that in the reduction of its incisor teeth to $\frac{2-2}{1-1}$ and in the rudimentary or transitional condition of the cheek teeth, *Macrorhinus* is removed from any approach to the stable and characteristic dentition of the *Otariidæ*, or even of some of the *Phocidæ*, but it is an open question whether we are justified in making the teeth a character of such paramount importance in classifying the *Pinnipedia*, seeing that they are variable to an extraordinary degree. Not only in number, but in shape, size, and character, as well as in the number of the roots, there is hardly a species which does not give a most unusual number of variations.

## ARCTOCEPHALUS HOOKERI.

*Hooker's Sea-Lion.*

(Plate IV.).

*Arctocephalus hookeri*, Gray, Zool. Voy. Ereb. and Terr., Pl. XIV., XV.; Hutton and Drummond, Animals of New Zealand, 1904, p. 36.
*Phocarctos hookeri*, Allen, Hist. N. Amer. Pinnipeds (1880), p. 209, *ibique citata*.

### List of Material in the 'Discovery' Collection.

No. 27, ad. skin and skull ♀. March 20, 1904. Laurie Harbour, Auckland Islands. (Seals, Plate IV.).
No. 31, ad. skin and skull ♀. March 20, 1904. Laurie Harbour, Auckland Islands.
No. 44, juv. skin and skull ♂. March 20, 1904. In process of moulting the red hair in which it was born. (Seals, Plate IV.). Enderby Island, Auckland Islands. The skull contains several milk teeth.

The colouring of the soft parts is as follows :—

Iris, dark brown.
Uncovered portions of the hind and fore limbs, all black.
Nails, dark brown.

Note on Seals, Plate IV.; the position and outline of the adult female is taken from a photograph supplied to me by Mr. McGregor Wright, of Wellington, N.Z., who happened to visit the Auckland Islands during our stay there, and kindly gave me permission to use his photographs in this publication. See also figs. 33 and 34, p. 64.

On her homeward journey from the Antarctic to New Zealand, the 'Discovery' was anchored for a fortnight (March 15th to 29th, 1904) in Laurie Harbour, at the north-eastern end of the Auckland main island. This stay brought us in touch with Hooker's Sea-lion (*Arctocephalus hookeri*), which we found to be abundant in our neighbourhood, a large number frequenting a stretch of sandy shore about half a mile long on the southern side of Enderby Island, which lies just outside and to the north of Laurie Harbour. In Laurie Harbour itself we were visited by adult females and young adult males, but the oldest and largest males were only to be seen on the sandy beach of Enderby Island, and an account of our visit to it will convey the greater part of our observations concerning the habits of the animal.

It may first, however, be stated that the exact range of Hooker's Sea-lion has not been very satisfactorily determined. There is much doubt as to the propriety of considering the variously named species of *Arctocephalus* as distinct, and until this matter is cleared up it is almost impossible to say where *Arctocephalus hookeri* has or has not been found. Gray reports it from the Falkland Islands and Cape Horn, and probably the south coast of Australia. It is also said to frequent the west coast of New Zealand, Bass Strait, and the west coast of Tasmania (Sir James Hector). It quite certainly occurs abundantly on the shores of the Auckland Islands; and the sandy beach of Enderby Island seems to provide the requirements of a breeding "rookery," since we there found old males with their harems around them, as well as two young ones quite recently born. Along the whole length of this sandy beach were these Sea-lions, the majority young males and females; but there were also about twenty full grown and very large dark brown bulls with thick manes of short, rough and curly hair (figs. 31 and 32, p. 60).

Wherever we went into the bush which covered the island, even half a mile inshore, in the thickest scrub or amongst the mounds of tussac grass, often half-way up a quite considerable hill, we found ourselves confronted by half awakened Sea-lions. In the scrub adjoining this sandy beach we discovered a very young one, dead, but quite fresh. This was a particularly interesting specimen,* because it had just commenced shedding the reddish-brown hair in which it was born. From nose to tail its skin measures 42 inches. The hind flippers extended behind add another 8 inches to its length, and the fore flippers are 9 inches long. The bright chestnut-red hair which covers it is fine in texture, straight and abundant, each hair measuring $\frac{3}{4}$ inch (17 to 18 mm.) in length. The ventral surface is as red and as dark as the dorsal, but the shoulders and the lower part of the back and flanks are of a decidedly darker shade

* There is, in the B. M. Coll., a similar skin of *Arctocephalus hookeri* of about the same age, showing exceedingly well the pale crown, mentioned on p. 61; but the skin has no history.

Fig. 31. Hooker's Sea Lion, old bull and cows, in the Auckland Islands.

Fig. 32. Hooker's Sea Lion, adult, in the Auckland Islands.

*To face p. 60.*

than the back; and the whole of the face, the chin, muzzle, cheeks, eyebrows and throat are all distinctly darker and browner than the remainder of the body. From the forehead, over the crown of the head, nape and back of the neck as far as the shoulders, the colour is paler than any other part, and may be described as a pale buff or light yellowish brown.

I would draw attention to the possible significance of this pale coronal patch of colour in connection with the question of the origin of the Sea-lions. It is more marked in this youthful individual than in older specimens, though it is plain enough in some of the fully adult examples of other sea-lions (in *Otaria lobata*, for example, and to a less degree in *Otaria jubata*) in the collection of the British Museum, and it is highly suggestive, occurring thus prominently in this new-born example, of the very similar coronal white and light patches of colour that occur in certain of the *Mustelidæ*, notably, for example, in the Badgers and Ratels, and the Sea-Otter, the most seal-like, in some respects, of all.

The specimen we procured was, as I have said, on the point of moulting its natal coat, and in place of the reddish hair, which had been shed in more or less confluent patches over the centre of the back and sides, mouse-grey coloured hairs had appeared, darker upon the back and paler laterally, a colour which characterises many of the young adults. It is noticeable that the moult commences in a different way in this animal to that which obtains in the natal moult of *Leptonychotes*, where the head, fore flippers, and hind flippers are invariably the first parts to show new hair, sometimes accompanied, but never preceded, by the moult of the median dorsal area. In this young example of Hooker's Sea-lion, although the back is moulting, there is no sign of moult upon the head or flippers. The hairs composing the new coat are very fine and short (10 mm. in length), their terminal quarter being white, and the remainder dark grey or black, the mixture of black hairs and white ends producing the soft mouse-grey colouring characteristic of the young and some of the females of Hooker's Sea-lion.

The fore and hind limbs are uniformly covered to the roots of the nails with the same red-brown hair that covers the body. The naked parts of the limbs are black. On the fore limb are five minute rudimentary nails, and on the hind limb well-formed nails, 12 mm. long, upon the second, third, and fourth digits, and rudimentary nails only upon the first and fifth. The ears are comparatively long and pointed, measuring fully 20 mm. in length, the pinna drooping downwards and backwards. The facial bristles are long, strong, and white for the most part. The hinder ones are the stronger and in some cases, are of a slightly darker shade. The nostrils, 12 mm. long, open directly forwards, and are divided by a comparatively narrow septum. The distance separating the bare black skin of the nose from the upper lip is 7 mm., and this space is covered with short reddish hair. In the pes the first digit extends its palmation 25 mm. beyond that of the fifth, that of the second, third, fourth, and fifth being equal. The tail measures 35 mm. in length.

In the skull of this young specimen the most prominent teeth in the upper jaw are the two incisors on each side, and they are almost twice the size of the corresponding teeth in an adult female. The third or outermost incisor only just shows through the gum, and this is one of the permanent set, for just anterior to its emerging point on each side may be seen the small socket for the deciduous tooth closed over by the gum. When this was opened up by dissection, a minute third incisor of the milk dentition was found embedded in it. There are therefore on each side three incisors of the milk dentition in the upper jaw, the two central being larger than those which follow of the permanent set, and the third minute. The canines of the milk dentition are next in prominence to the incisors. Each of these has a long conical crown extending 10 mm. beyond the gum, straight and pointed. Next to these, and towards the median line, if the gum is dissected away, the points of the permanent canines can be disclosed.

The first pre-molar is the largest and most prominent tooth in the upper jaw. Next to it comes a tooth, the point of which has but just pierced through the gum. The third is more advanced; the fourth, again, is just showing through the gum; the fifth post-canine, or first molar, shows two of its three cusps, the central and the posterior, through the gum, and the second molar was completely hidden in the gum, until disclosed by dissection. All these are teeth of the permanent dentition, the cheek teeth of the milk dentition, mere caps of dentine in the surface of the gum, having dropped from their hold in the lower jaw, though some of them still remain *in situ* in the upper jaw. As to their number no definite statement can be made from the specimen, though the position of the few that remain makes it probable that there are four pre-molars in either jaw. In the lower jaw again, when compared with the lower jaw of a young adult, the inner tooth of the two incisors of the milk dentition is considerably larger than the permanent tooth which follows it; in shape and character the inner of the two deciduous incisors is almost the exact counterpart of the outer of the two permanent incisors, whereas the outer of the two deciduous incisors is much like a small edition of the permanent canine. The inner of the two permanent incisors again is a small and insignificant tooth resembling neither of the deciduous incisors. The canine tooth of the milk dentition is *in situ* on each side in the lower jaw, and has a long and pointed cylindrical crown 8 mm. in length. Just within and slightly behind it can be found deeply imbedded in the gum the point of the permanent canine. Behind this is the most prominent tooth in the lower jaw, the first permanent pre-molar with a large central and a minute anterior cusp. Just behind it can be seen two minute sockets in the gum from which the small deciduous teeth have quite recently fallen. Posterior to these the central cusps of the second, third and fourth pre-molars are just appearing through the gum. On the outer side of the fourth on the right side is a small depression for a milk tooth recently lost, and on the left side this milk tooth is *in situ.* The central cusp of the single lower molar is just beneath the surface of the gum.

The formula for the milk dentition in this species is probably as follows :—

$$I\,\frac{3-3}{2-2},\quad C\,\frac{1-1}{1-1},\quad PC\,\frac{4-4}{4-4}.$$

The formula for the two adult females in the 'Discovery' collection is in each case :—

$$I\,\frac{3-3}{2-2},\quad C\,\frac{1-1}{1-1},\quad PM\,\frac{4-4}{4-4},\quad M\,\frac{2-2}{1-1}.$$

The skin of one of the females (No. 31) measures 68 inches from nose to tip of tail. The length of the fore flipper is 13½ inches, the length of the hind flipper 15½ inches. The colouring is a uniform buff, or creamy grey, very slightly darker and greyer dorsally owing to the fact that the basal two-thirds of every hair are black and only the terminal third is buff, whereas in the lateral and ventral areas the hairs are completely buff.

The fore limb of this adult female carries five minute and rudimentary nails. The naked dorsal palmation is carried 4½ inches beyond the position of the nail in the first digit, 2 inches beyond that of the second digit, 1 inch beyond that of the third, and ½ inch beyond that of the fourth and fifth. The palmar surface is devoid of hair over its whole extent, forming a sole 12 inches in length and 4½ inches across the base. The radial border of the limb is also devoid of hair on the dorsal surface. In the hind limb, nails 30 mm. in length are developed on the three central digits, while the first and fifth are provided only with rudimentary suggestions. Beyond the position of the nail on the dorsal surface of the first digit is a naked palmation of 13 cm. in length and 4 cm. in width. Beyond the nail insertion in the second digit there is a palmation 10 cm. long, in the third 9 cm., in the fourth 9 cm., and in the fifth 9 cm., but the width of the fifth, 2 c.m., is just double as much as the width of the second, third or fourth. The palmar naked sole of the hind limb extends to within 2½ inches of the root of the tail, and measures 13 inches by 4 inches at its widest part. The same features and the same proportions hold good also for the limbs of the young, in which the distribution of hair and naked skin is precisely the same as in the adult females. The nostrils of the adult female are 22 mm. in length, and the hair-covered space between the nostrils and the upper lip is 22 mm. As in most seals, the hair immediately adjoining the lip is a darker chestnut red, and of a longer softer character in this seal, especially along the lower lip. It is the only part of the adult that retains the chestnut red colour characterising the new-born young.

The females on the sandy beach of Enderby Island were divided into parties which were collected around the older rough-haired males. The old males have a far coarser and darker hair than the younger males and the females, and have also a very thick crisped blackish brown mane, which clothes the whole of the enormously muscular neck. In the younger males one sees innumerable scars upon the neck, but these are not visible under the crisped mane of the larger males. The mane, no doubt, is developed largely as a protection in the fights that constantly occur between them. While

thus employed, they stand erect, supporting themselves on their fore limbs, quite close to one another, with wide, gaping mouths making from time to time most vicious snatches each at the other's neck (see Figs. 33, 34, p. 64). The largest males were the most phlegmatic, until roused by the approach of another of their own sex, when they would at once show signs of disapproval, and if this was not sufficient, would make for the intruder and drive him off.

They took very little notice of us, but the females would leave their masters' company, and follow us in small crowds, galloping with quick bounds, their long necks outstretched and mouths agape, emitting all the while a kind of bark or hoarse cough. When they came too close, shooting out and withdrawing their long necks in the most rapid manner imaginable, and coming a little closer at every snap, we had to drive them off with sticks and seaweed roots. They were easily frightened, though they soon regained confidence, and it was far from pleasant to walk along the beach with half-a-dozen snapping sea-lions at one's heels, each one encouraging its neighbours to press the attack a little closer. Occasionally one of the females would put all timidity on one side, and rush straight up with long hops from a distance of twenty yards, with the obvious intention of doing mischief. The slightest knock on the nose would, however, make her turn and retire as rapidly as she had come.

The females were always far smaller than the males, and were either bluish-grey or buff or cream-coloured, with very sleek coats. Some had a beautiful steel-blue gloss all over, while others were cream-coloured except for the heads and shoulders, which might be a steel-blue grey.

The males were uniformly dark and blackish-brown, head, neck, mane, and body; very ugly, with large, dark, lustreless, weeping eyes, and a high ridged head which suggested that of the bloodhound when looked full in the face. Moving about in a stately manner on all fours, they looked like large brown bears with their feet cut off, as though they were walking about on the stumps. The larger males were at least three times as bulky as the largest females, and each one guarded five or six of the latter which lay in a circle round about him. The females, unlike the males, were active in all their movements, galloping about freely and attacking one another within the sphere of their masters' protection.

There were only two small pups, and only one of these in the red chestnut coat of its birth. The other was the size of a large terrier, and exceedingly active, reminding one much in its movements of a dog running here and there about its mother, which lay with a group of females.

We were on Enderby Island in the third week of March, and we believed that the two young ones that we saw were exceptionally late arrivals, and that the majority of the young around us were hardly to be distinguished from the females.* In the Trans. N.Z. Inst., 1892, however, there is a note by Sir James Hector concerning this Sea-lion, in which he says: "The males take up their stations on the coast in

* See Hutton & Drummond, *Op. cit.*, p. 36.

FIG. 33. HOOKER'S SEA LION.

FIG. 34. HOOKER'S SEA LION.

December. Soon after the cows appear, and on landing give birth to the young, each male securing a harem of ten to twenty cows, and protecting the mothers and young pups. The rutting season is in January, after which the males leave the mothers to bring up the young until May, when they all leave the coast for the winter."

It will be seen at once that this account does not agree with our observations. There is no doubt that the males when we were there in the third week of March had not left the rookery, neither is there any doubt that the young one which we procured had died very shortly after birth, not more than the day before we found it, and as there was but one other small pup upon the beach, it was natural that we should have surmised that they were both either very early arrivals or very late, with a probability of the latter, as they were born in the latter end of March; moreover, the fights that we saw between the males, as well as the definite collection of so many harems around them, led us to think that the breeding season might be in progress, perhaps later in the Auckland Islands than on the west coast of New Zealand, where Sir James Hector made his observations, many years ago. In his note he goes on to say that "the mode of life of the hair seals has been much altered since 1863, when I made my first observations, and I believe that the New Zealand Hair Seals (*Protoarctus hookeri*) have now become much more solitary, and that they will soon become extinct."

While it is quite possible that the colonies might be broken up to some extent, it is hardly likely that they could have changed the month in which the young were to be born. As Sir James Hector's observations are the result of a longer experience and observation than our own, we can only think that the pups we saw were born a month or two later than is usually the case, and that the rest of the young perhaps had gone to sea.

The food of Hooker's Sea-lion in March appeared to consist exclusively of a large red crab. No doubt the diet varies from one season to another, for it is hardly probable that they would find the same crustaceans while they lived mainly on shore and visited only shallow water that they would find while living a more pelagic life during the winter months. Fish would then, no doubt, form a considerable proportion of their food.

The large red Auckland Island crab is known as *Nectocarcinus antarcticus*, and is a shallow water form. We know that the sea-lions eat them in large numbers, because we found evidence of it everywhere along the shore and in the bush. The Sea-lions, having satisfied themselves at sea, come in shore, and make their way into the bush, where, amidst the rank growth of scrub and tussac grass, they sleep, and sooner or later regurgitate a bolus composed of the undigested remnants of the crabs, whose legs and shells are rolled into a mass the size and shape of a hen's egg.

We saw the Sea-lions upon occasions chasing such birds as Cormorants, and probably anything that would be food to an ordinary carnivorous appetite would be food also to them.

We had, one night, a very interesting experience in observing the phosphorescence that was stirred up in the sea by the movement of these animals. Coming back to the ship by boat from Enderby Island an hour or two after sunset, and on a particularly dark night, with neither stars nor moon, we watched the sinuous and graceful movements of about six large Sea-lions that followed our boat apparently out of curiosity. Diving and twisting about beneath us in the pitch-black water each animal was ablaze with light. Every limb and every movement could be seen, though they moved so rapidly that the eye could scarcely follow them; they played with one another and chased one another and the boat, now coming up to blow, as we could hear, a yard or two astern, and now diving deep down under the boat to appear often close in under the bulwarks; every stroke of the long powerful fore flippers was accurately conveyed to our eyes in the pitchy darkness by the brilliance of the phosphorescence coating them. We watched long to see if they ever used the hind flippers as propellers, and though this happened only on very rare occasions, we satisfied ourselves that they were occasionally brought forward to assist the pace by a powerful stroke in unison.

Throughout this long pull in the dark we saw not a single fish or other beast lit up in the same way, and although we could hardly wonder at this, considering how ample a warning they had of the approach of their enemies—the Sea-lions—we yet thought that possibly the smooth and frictionless mucoid covering of the fish might be of some use, not only in facilitating their speed through the water, but also in preventing a similar declaration of their whereabouts whenever, as so often happened, the sea was full of organisms prepared to phosphoresce. No doubt the striking brilliance of the Sea-lions was due to the roughness of their hairy coats, and every organism that came in contact therewith would phosphoresce at once and brilliantly. It must very materially embarrass an animal's prospects of obtaining food if, on every warm night, it is bound to declare its presence in this manner.

The sight was a most beautiful one. The animals moved with feints, and twists, and turns, now in curves, now in circles, but always with the sinuous motion of the body like a fish, supplemented by powerful strokes of the long fore flippers, and always with the most wonderful rapidity. All this we saw most clearly in the blackest darkness, far more clearly, indeed, than such objects are wont to be seen even under the most favourable conditions, in the daylight.

# INDEX.

# WHALES.

## PLATE I.

An unnamed and as yet undescribed whale is represented, in fig. 1, as it rises to blow ; in fig. 2, as it appears just after blowing ; and in fig. 3, as it sounds, just before disappearing. Fig. 2A represents an example of the same species with the dorsal " fin " curved abnormally forward, instead of backward. (*See* Mammalia, p. 4.)

Antarctic (Discovery) Exp.   Whales, Plate I.   Bale & [illegible]

SEALS.

PLATE I.

An adult female Weddell's Seal (*Leptonychotes weddelli*), with her young one, about a week old. $\frac{1}{10}$ nat. size. (*See* Mammalia, pp. 10–26.)

SEALS.

PLATE I.

An adult female Weddell's Seal (*Leptonychotes weddelli*), with her young one, about a week old. $\frac{1}{10}$ nat. size. (*See* Mammalia, pp. 10–26.)

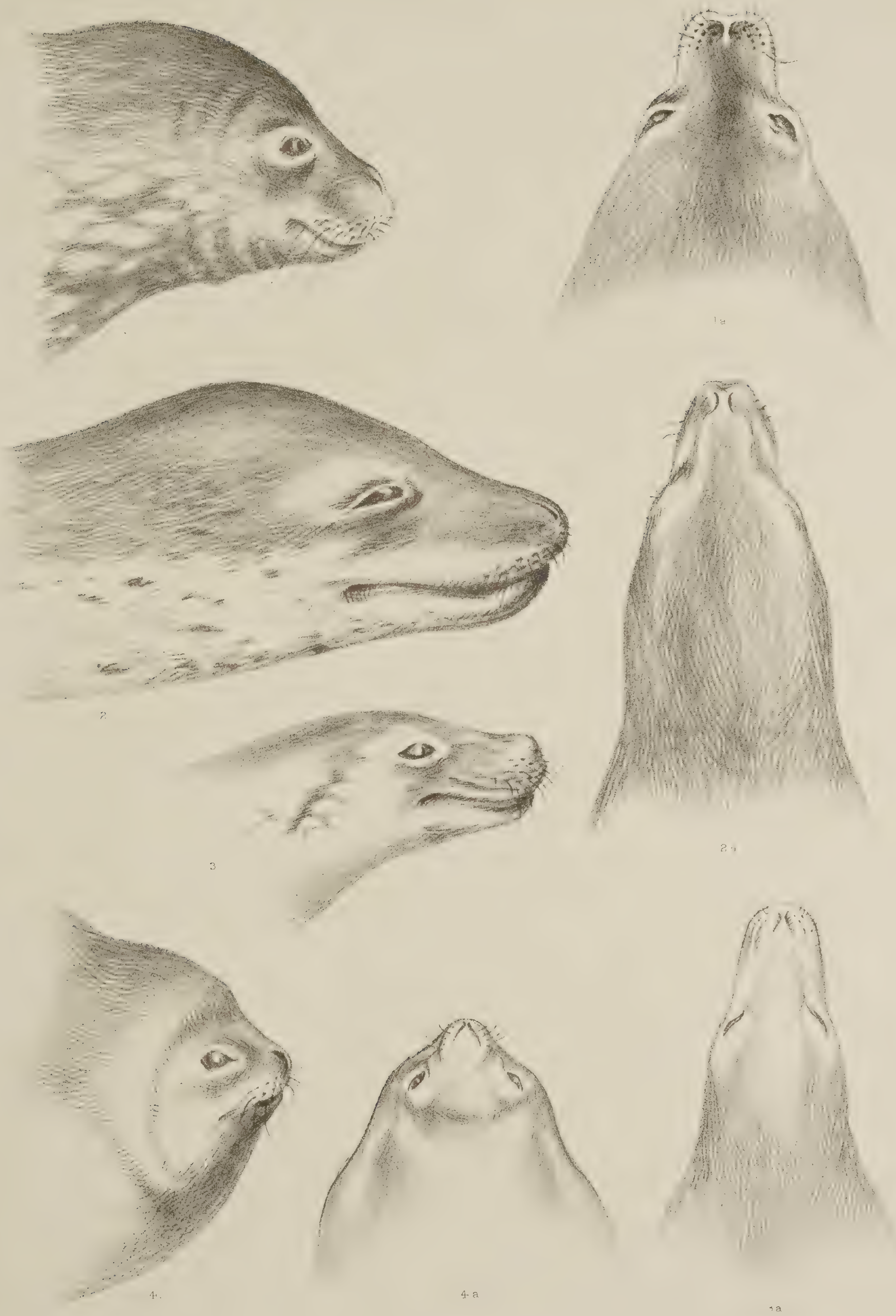
Antarctic (Discovery) Exp. Seals, Plate I.

E. A. Wilson pinx
Bale & Danielsson, Ltd Lith

## SEALS.

### Plate II.

The heads, in profile and from above, of the four common Antarctic Seals. Figs. 1 and 2 represent Weddell's Seal (*Leptonychotes weddelli*), figs. 3 and 4 the Sea Leopard (*Stenorhinchus leptonyx*), figs. 5 and 6 the Crab-eater (*Lobodon carcinophagus*), figs. 7 and 8 Ross' Seal (*Ommatophoca rossi*). Although reduced to about one-sixth natural size, the relative sizes of the drawings are intended to be correct for the average of each species.




Antarctic (Discovery) Exp.

Seals, Plate II.

E. A. Wilson del.
Bale & Danielsson, Ltd lith.

## SEALS.

### Plate III.

Part of the upper and lower jaws of an old Weddell's Seal (*Leptonychotes weddelli*), showing excessive wear in the canines and incisors (*see* Mammalia, p. 22), with disease and injury of the canines of both jaws on the left side.


Antarctic (Discovery) Exp. Seals, Plate III. A. J. Terzi del. Bale & Danielsson, L^td imp.

## SEALS.

### Plate IV.

An adult female of Hooker's Sea Lion (*Arctocephalus hookeri*), with her young one, on the Auckland Island coast. The colouring is taken from skins 27 and 44 of the 'Discovery' Collection (*see* Mammalia, pp. 59–66).

Seals, Plate IV.

E. A. Wilson pinx
Bale & Danielsson, L$^{td}$ lith

Fig. 1. Emperor Penguins' Rookery at Cape Crozier.

Fig. 2. Emperor Penguins' Rookery at Cape Crozier.

To face p. 1.

# II. AVES.

By Edward A. Wilson, M.B.

(13 Plates.)

## APTENODYTES FORSTERI.

*The Emperor Penguin.*

(Plates I.—VII.)

*Aptenodytes forsteri*, Gray, Ann. Mag. Nat. Hist. xiii. (1844), p. 315 ; Sharpe, Rep. 'South. Cross' (1902), p. 109, *ibique citata ;* Eagle Clarke, Birds of South Orkneys, Ibis, Jan. 1906, p. 166 ; K. A. Andersson, Wiss. Ergeb. der Schwed. Südpolar-Exped., Bd. V. 2 (1905), pp. 19–21.

List of Material in the 'Discovery' Collection.

No. 25, ♀, imm. sk. 17 months. About to moult. Feb. 5, 1904. McMurdo Sound.
No. 26, imm. sk. 17 months. About to moult. Feb. 5, 1904. McMurdo Sound.
No. 27, imm. sk. 5 months. Jan. 6, 1902. Pack ice, 68° S. 178° E.
No. 28, imm. sk. 5 months. Jan. 6, 1902. Pack ice, 68° S. 178° E.
No. 29, imm. sk. 5 months. Jan. 5, 1902. Pack ice, 68° S. 178° E.
No. 30, ♂, ad. sk. April 8, 1902. McMurdo Sound.
No. 31, ♀, ad. sk. April 8, 1902. McMurdo Sound.
No. 32, ♂, ad. sk. Sept. 30, 1902. McMurdo Sound.
No. 33, ♂, ad. sk. April 8, 1902. McMurdo Sound.
No. 34, ♀, ad. sk. April 8, 1902. McMurdo Sound.
No. 35, ad. sk. April 8, 1902. McMurdo Sound.
No. 36, ♀, ad. sk. This bird weighed 90 lbs. in the flesh. April 8, 1902. McMurdo Sound.
No. 37, ad. sk. April 8, 1902. McMurdo Sound.
No. 38, ♂, ad. sk. April 8, 1902. McMurdo Sound.
No. 39, ♀, imm. sk. 17 months. About to moult. Feb. 6, 1904. McMurdo Sound.
No. 40, ♀, ad. sk. Feb. 8, 1904. McMurdo Sound.
No. 42, ♂, ad. sk. in full moult. Weighed 73 lbs. in the flesh. Jan. 15, 1903. McMurdo Sound.
No. 44, ♂, ad. sk. April 8, 1902. McMurdo Sound.
No. 45, ♀, ad. sk. April 8, 1902. McMurdo Sound.
No. 46, ♀, ad. sk. April 8, 1902. McMurdo Sound.
No. 47, ♂, vix ad. sk. Just moulted from immature plumage. Age 17 months. Jan. 6, 1902. Lady Newnes Bay.

No. 48, ♀, ad. skin. April 8, 1902. McMurdo Sound.
No. 49, ♀, ad. skin. Sept. 30, 1902. McMurdo Sound.
No. 50, ♂, ad. skin. April 8, 1902. McMurdo Sound.
No. 51, ♂, ad. skin in full moult. Jan. 15, 1903. McMurdo Sound.
No. 93, ♂, juv. skin. } Oct. 18, 1902. Cape Crozier.
No. 94, ♀, juv. skin.
No. 224, juv. in spirit, found dead. Oct. 18, 1902. Cape Crozier.
No. 95, ♂, juv. skin.
No. 96, ♀, juv. skin.
No. 97, ♂, juv. skin.
No. 98, ♀, juv. skin. } Found dead. Nov. 18, 1902. Cape Crozier.
No. 102, juv. skin.
No. 103, ♀, juv. skin.
No. 105, ♀, juv. skin.
No. 99, juv. skin. Alive in captivity from Sept. 13, 1903 to Dec. 10, 1903. Cape Crozier.
No. 100, juv. skin. Nov. 8, 1902. Cape Crozier.
No. 101, ♂, juv. skin. Sept. 26, 1903. Cape Crozier.
No. 104, ♂, juv. skin. } Found dead. Sept. 13, 1903. Cape Crozier.
No. 106, ♀, juv. skin.
Nos. 186 to 199 incl., juv., in formalin and spirit. Found dead. Sept. 13, 1903. Cape Crozier.
Nos. 200 to 205 incl., juv., unhatched, in spirit. Found dead. Sept. 13, 1903. Cape Crozier.
No. 206, egg. Fully incubated, putrid.
No. 207, egg. Fully incubated, putrid. 365½ grms.
No. 208, egg. Fully incubated, putrid. 403½ grms.
No. 209, egg. Partially incubated, wholly rotten. 211½ grms.
No. 210, egg. Fully incubated.
No. 211, egg. Fully incubated, putrid.
No. 212, egg. Fully incubated.
No. 213, egg. Fresh laid, burst by freezing. } Sept. 13, 1903. Cape Crozier.
No. 214, egg. Fresh laid, burst by freezing.
No. 215, egg. Fresh laid, burst by freezing.
No. 216, egg. Slightly incubated. 448½ grms.
No. 217, egg. Fully incubated.
No. 218, egg. Fresh laid, contents altered by freezing.
No. 219, egg. Fresh laid, contents altered by freezing.
No. 220, egg. Wholly putrid. The first example, found by Lance-Corpl. Blissett, R.M.L.I., under Lieut. Royds, R.N. Nov. 8, 1902. Cape Crozier.
Nos. 182, 183, ad. skel. ♀. Jan. 30, 1904. McMurdo Sound.

The colouring of the soft parts is given in detail below. See pp. 20, 21.

### List of Material in 'Morning' Collection.

A. No. 43, ♂, imm. skin. Five months. Jan. 1904. Pack ice, 70° S. 176° E.
B. No. 45, ♂, ad. skin. About to moult. Jan. 1904. McMurdo Sound.
C. ad. skin. South Victoria Land.
D. ad. skin. South Victoria Land.
E. imm. skin. Dec. 31, 1902. 70° S. 175° E.
F. ad. skin. South Victoria Land.
G. ♂, imm. skin. Dec. 31, 1902. 70° S. 175° E.
H. ad. skel. South Victoria Land.

NOTE ON THE ILLUSTRATIONS.

Plate I. represents the Emperor Penguin Rookery at Cape Crozier in September, looking eastward, along Ross' Great Ice Barrier.

Plate II. represents the head of an adult Emperor Penguin in full plumage. (Life size.)

Plate III. represents the heads of Emperor Penguins at various stages of growth. Figs. 1 and 2, the heads of chicks in down at one week and one month. Figs. 3 and 4, of immature birds at five and six months. Figs. 5 and 6, of immature birds at seventeen months. ($\frac{1}{3}$ life size.)

Plate IV. is from one of the frozen chicks picked up on the ice at Cape Crozier. It required no support to stand thus while frozen, but probably would not stand so erect in life. It is drawn as it was picked up, but erect instead of lying on its side.

Plate V. represents the feet of young chicks and an adult.

Plates VI. and VII. represent four Emperor Penguin's eggs, life size, taken from the rookery at Cape Crozier. Plate VI., fig. 1, is the smallest, Plate VII., fig. 1, the largest of the series. Fig. 2 on each plate represents a variation of surface.

OUR first introduction to the Emperor Penguin, the largest and the handsomest of all living penguins, occurred on January 4th, 1902, when we had entered the pack ice and were making the best of our way towards open water again to the south. The birds were scattered here and there, singly, or in couples, and much to our surprise we found that almost all were immature. It was not until we had worked our way through the pack ice, and had begun to coast along South Victoria Land, that we realised that we had left the region frequented by the immature and had come amongst adult birds. Even now, however, these were few and far between; we came across a few companies of eight or ten in the bay named after Lady Newnes, and they were in full moult, but afterwards we saw still fewer until we came to the fast ice of King Edward VII.'s Land, at the extreme eastern end of Ross' Barrier.

Passing by McMurdo Sound in our search for winter quarters we sailed to the eastward till we came to the rocky cliffs of Cape Crozier, under Mount Erebus and Mount Terror, the two volcanoes which form what is now known as Ross Island. These high rocky cliffs abut on the ice cliffs of the Great Ice Barrier, and where the ice and rock cliffs meet at an angle they enclose a bay. On the ice of this little bay, as we discovered some nine months later, a very large number of Emperor Penguins collect year by year to form a breeding "rookery" (figs. 1 and 2, p. 1; also fig. 5, p. 8). But in January of 1902, when we first reached the spot, the ice was all gone out, and not an Emperor Penguin could be seen, nor was there the least suggestion of the rookery's existence, though the ice on which it stood could hardly have been broken up much more than a month before. Not a single Emperor Penguin was in sight, either young or old, as the 'Discovery' passed the spot in January and made her way to the eastward along the sea face of the Great Ice Barrier.

After sailing for over a week along this ice cliff, 500 miles in length, and of a height which averaged 200 feet, we came at length to its eastern confines and discovered the new land mass now called King Edward VII.'s Land. Here in a bay,

while the ship was beset with new ice, we first began to suspect that we were nearing the Emperor's breeding haunts. Away in the distance, over some miles of disintegrating ice-floe, could be seen large companies of birds which, when viewed through the telescope from the crow's nest, proved to be Emperor Penguins. Large and dark, standing in colonies here and there under stranded icebergs, were many hundreds of them, and between them and us, in the water and on the ice, now crying aloud to one another, now leaping like salmon to land upright on the edges of the floe, were such numbers as had never before been seen together. Knowing nothing of their habits, it was natural that we should believe that here at last was the long-looked-for breeding ground; and our disappointment, on realising that we could not attempt to reach it, may be easily imagined.

The navigable season was already at its close, the sea ice was freezing hourly thicker, the miles of disintegrating ice between ourselves and the apparent rookery was a barrier to closer intercourse, and the near approach of winter made it imperative that we should speedily find winter quarters and avoid by all possible means being frozen in exactly where we were. So the question for the time remained unsolved. When, nine months later, we discovered that the Emperor Penguin lays and incubates its egg through the winter darkness; that the chicken emerges from the egg at the beginning of September; that it has shed its down and taken up an existence, independent of its parents, by the middle of January, we began to wonder whether, after all, the collection of birds in King Edward VII.'s Land was, in truth, a breeding colony, or whether it was not rather a large collection of moulting birds, waiting on fast ice till their new plumage had appeared and they might be able to take to water once again.

This, no doubt, was the true explanation of our seeing birds in such numbers at so late a date as January 31st and so far south as lat. 76°. To return, however, to our search for their breeding-place. We had settled into McMurdo Sound for the winter after returning westward from King Edward VII.'s Land along the Barrier Cliff. Again, we had passed the little bay under the cliffs of Cape Crozier, and quite close by in the middle of a very extensive rookery of Adélie Penguins we had left a record for the relief ship 'Morning' to pick up in the ensuing year. And then, when our first dark winter lay behind us, the spring sledging was begun, and with it preparations were completed for the longer extended journeys that were to occupy the summer months.

A few days only before Captain Scott started on his long Southern sledge journey, taking with him Lieutenant Shackleton and myself, three frozen chickens were brought to the ship from the Emperor Penguin rookery, discovered then for the first time at Cape Crozier by Lieutenants Royds and Skelton. Having skinned these birds, and having heard a most interesting account from Lieutenant Skelton, who had brought home the minutest details, we had at once to leave the ship for the South. All further investigation on my part was therefore necessarily postponed till the following year, but Lieutenant Royds kindly volunteered to make a second journey to the spot and hunt more rigorously for eggs, and, if possible, find answers to quite a number of questions

Fig. 3. Emperor Penguins.

Fig. 4. Emperor Penguins.

*To face p. 4.*

that suggested themselves before we could say we understood the breeding habits of the bird.

It was not till three months later, on our return from the farthest South, that we learned how the first Emperor Penguin's egg, deserted, half buried in the ice, and full of putrid chicken, had been found. The egg, however, was not the only result of this journey. The party which arrived at Cape Crozier on November 8th was surprised to find that all the chickens hatched that year had disappeared. Again and again they put large packs of Emperors on the run, but not a living chicken could be found. On November 10th they again went down to the rookery, and now there were hardly any Emperors left at all. The migration to the North was obviously completed, but how had the chicks been taken? One thing was amply certain, that before their down was shed they could not have gone by water. This problem remained unsolved till the ensuing year, but there are further points in connection with this year's journeys which must first be mentioned.

Excellent to a degree which could hardly have been surpassed under much more favourable conditions, were the photographs taken on the spot by Lieutenant Skelton. Taken though they were at a temperature of 40° below zero, Fahrenheit, and after a couple of hours' climbing over crevassed and chaotic pressure ridges of ice and snow with rope and ice axes, they show, nevertheless, all the characteristics of the rookery, and examples of every position assumed by the birds in sleep and incubation.

Of the first three chickens brought back to the ship one had been picked up dead and frozen on the bay ice. It had probably died within a week of emerging from the egg, and had been roughly handled by the parents both before and after death. The down on the head and body was nearly all worn off. The brittle frozen wings were broken. There was a large rent in the skin of the neck, and marks of the old bird's claws upon the body. The other two chickens had been taken alive from the parents. In these, too, were a number of small cuts in the wings and a wound in the neck. But of the significance of these mutilations I have more to say below. The only remains of egg-shell found by the first party were such as adhered to the frozen excreta, broken bits of thick white shell and membrane which had obviously been swallowed when the eggs were hatched, and had become wrapped round the undigested remains of fish-bone. From this we gathered that the eggs were laid and hatched in all probability on the sea-ice where the rookery was situated, and that there had not been any migration to the spot after the hatching of the chicks.

It appears then that in the Emperor Penguin we have a bird which not only cannot fly, and lives on fish which it catches by pursuit under water, but which never steps on land or on land ice even to breed, and has so modified its habits that it carries out the whole process of incubation on sea ice, choosing those months of the Antarctic year when the greatest cold ensures a solidity of sea-ice which can be trusted. Without anticipating further the habits of the bird, I must now pass to an account of the third year's journeys to the rookery.

It must be remembered that its distance from our winter quarters was close on 50 miles, and that in early spring a sledge journey to cover the distance there and back necessitated considerable forethought and preparation. For one thing, the surface snow was liable to give one very heavy travelling, and for another, the number of hours of daylight in September were few, and the day's march therefore short, while camping had to be managed after dark by the light of a piece of candle. The temperatures moreover were severe to a degree which had never before been experienced in extended journeys, and ranged sometimes for ten days together from anything below $-30°$ F. and $-40°$ F. down to $-63°$ F. The first point therefore in the following year was to decide upon the earliest practicable date on which it would be wise to make a start, and this we had to judge from the following fact which was all that we possessed—namely, that on October 18th of the previous year there were chicks of apparently ten to fourteen days' growth.

We had no knowledge of the length of this penguin's incubation, but from Professor Moseley, quoting Goodrich, on the incubation period of the King Penguin we had the limit of seven weeks given for our guidance. If anything, the Emperor should have a longer incubation period than the King—first, because it is the bigger bird and the period of incubation is said to vary with the size of the bird; and second, because the temperature of the surrounding air is very distinctly lower than it is in the regions where the King Penguins breed; and this also has been said to prolong the time necessary for the purpose. So, as the first week of September was the earliest date at which there was light enough for travelling, we decided to make a start upon the 7th. The party consisted of Lieut. Royds, myself, and four seamen, with two tents and sledges. We believed that if we arrived from a month to six weeks earlier than in the previous year we should certainly find eggs, incubated probably, but still unhatched.

On September 12th, when we arrived, we made our way to the sea ice across the pressure ridges full of hopeful anticipation, for we could already see that the birds were there in large numbers. What then was our dismay when we found that we were again far too late for eggs, and that every one of them was hatched. Again and again we examined "sitting" birds and found that they had young ones but not eggs. We sadly realized the error we had made in calculating the age of the October chicks, and finding no eggs, began to supply ourselves with a series of the nestlings. In collecting such, however, as were dead and frozen on the ice, we soon came to a spot where we could see that some catastrophe had befallen the breeding colony, for we found no less than fourteen eggs deserted, lying loose upon the ice, all frozen, and many burst by the freezing, but some still perfect and uncracked.

It was clear that there had been a fall of ice from the cliffs under shelter of which the penguins had been quietly sitting with their eggs a month or two before. That this heavy fall had crushed some we could guess, for it had crushed some eggs as well, but the birds that had escaped had dropped their eggs in terror and had bolted. It was strange, however, that whereas some that we found must have been frozen fresh soon

after they were laid, the majority were fully incubated, and these were rotten as a result of having undergone a further incubation after life in the egg had been extinguished by the cold. How the desertion of the new-laid eggs can be accounted for I am at a loss to know, unless indeed there was an earlier fall from the ice cliff when the incubation was beginning, followed by another towards its close. And this is possible, for the condition of the ice mass is constantly unstable, the ice sheet being always on the move. Had the eggs been deserted once and for all when the ice cliff fell they would not, of course, have been decomposed, for it was now September 13th only, and the sun which appeared on the Northern horizon on August 23rd, after an absence of one hundred and twenty days, had as yet no power to thaw, much less to assist in decomposing anything. The sea ice, moreover, on which the eggs were found had been formed only since the previous summer. It is therefore certain that the birds must have returned, when it was too late, to resume their duties of incubation till the eggs were completely rotten.

It is possible that the wholesale loss of eggs is not a rare occurrence. The ice cliffs used for shelter are so much undermined and so unstable from the pressure of the Barrier ice against Cape Crozier that no man in his senses would camp for a single night beneath them. Yet these birds huddle there for upwards of five months in every year persistently, and this may perhaps explain why so large a number of the Emperors are unemployed.

There were in this rookery adults both male and female to the number of about one thousand, and not more than one in ten or twelve was occupied at the time of our visit in rearing young. One may suppose that some had lost their eggs, and some their young, for all had the keenest possible desire to brood, and many that had tired of waiting to snatch up a living chick would nurse a dead one.

We now saw that the chickens with which the birds were at present occupied were distinctly smaller than those taken in October of the previous year. But the difference seemed far less than might have been expected for five weeks' growth. The growth, in fact, in the earlier stages of their life must be extremely slow.

At any rate we saw that the date for the laying of the eggs must be put back to the beginning of July. From seven to eight weeks seems a reasonable estimate for incubation, and the eggs are all hatched out by the first week in September. There were no eggs just hatching on the 12th, nor were there any recently discarded eggshells on the ice; nor were the smallest of the living chickens so small as some of the dead and frozen lying there, which must have died some days before our visit (*see* Plate IV.).

On our return from this early journey to the rookery, we brought back two living chickens to the ship, hoping to throw some light upon their rate of growth and the date at which the natal moult begins. We had amongst our party a seaman named Cross, a first-class petty officer in the Royal Navy, who took charge of the foundlings, and at 60° below zero denied himself the use of his sleeping jacket on the journey home to keep them warm. At every camp he fed them with well-masticated seal meat, and they were strong and well and lively when we reached the ship. I must

return to their further history later, and meanwhile continue to give an account of the fourth and last journey that we made to Cape Crozier on behalf of the Emperor Penguins.

Accompanied again by Cross and a naval stoker, Whitfield, I started for the spot on October 12th. Our journey out took just a week, and we arrived on the day on which Lieut. Skelton the year before had killed the chickens that he first brought home. It was possible, therefore, to compare the chickens of this year's brood with those of the previous year, and we found them as nearly as possible identical in size. Moreover, the chicken we had kept alive in the ship was fully as big now as the biggest in the rookery, and we felt we might rightly take its rate of growth as an indication of what was going on under the more natural conditions at Cape Crozier in the rookery itself.

The number of dead chickens had certainly increased during the month we were away. To compare with the last year's skins, I picked out two of the largest living chicks that could be found. All were in down, and not one showed any sign of an approaching moult. The unemployed adults were still to be seen nursing dead chickens here and there, or waiting for a chance to seize a living one.

We remained encamped as near the rookery as possible for close upon three weeks, experiencing a ten-days' blizzard, which kept us confined to our sleeping bags for no less than seven days. Nevertheless, it was not such an ill wind that it blew no good to us, for had it not been for this southerly blizzard, we should have missed what was one of the most interesting sights we saw.

It will be remembered that in describing the second journey made by Lieut. Royds to this rookery the year before, I said that he arrived on November 8th, and found that all the adults as well as all the chickens had disappeared. Our journey was therefore timed to watch, if possible, something of this migration to the north. The chicks, I knew, were still in down, and unfit to enter the water. How, then, did the parents take them north?

During the week that we were forced by the blizzard to be inactive, though we never actually saw the young ones taken, we saw enough to suggest a solution of this problem. The day before the storm broke we were on an old outlying cone of Mount Terror, about 1,300 feet above the sea. Below us lay the Emperor Penguin rookery on the bay ice, and Ross Sea, completely frozen over, was a plain of firm white ice to the horizon. There was not even the lane of open water which usually runs along the Barrier cliff stretching away as it does like a winding thread to the East and out of sight. No space or crack could be seen with open water. Nevertheless the Emperors were unsettled owing, there can be no doubt, to the knowledge that bad weather was impending. The mere fact that the usual canal of open water was not to be seen along the face of the Barrier meant that the ice in Ross Sea had a southerly drift. This in itself was unusual, and was caused by a northerly wind with snow, the precursor here of a storm from the south-west. The sky looked black and threatening, the barometer began to fall, and before long down came snowflakes on the upper heights of Mount Terror.

Fig. 5. Emperor Penguins' Rookery at Cape Crozier.

To face p. 8.

All these warnings were an open book to the Emperor Penguins, and if one knew the truth there probably were many others too. They were in consequence unsettled, and although the ice had not yet started moving, the Emperor Penguins had; a long file was moving out from the bay to the open ice, where a pack of some one or two hundred had already collected about two miles out at the edge of a re-frozen crack. For an hour or more that afternoon we watched this exodus proceeding, and returned to camp more than ever convinced that bad weather might be expected. Nor were we disappointed, for on the next day we woke to a southerly gale and smother of snow and drift, which effectually prevented any one of us from leaving our camp at all. This continued without intermission all day and night till the following morning, when the weather cleared sufficiently to allow us to reach the edge of the cliff which overlooked the rookery.

The change here was immense. Ross Sea was open water for nearly thirty miles; a long line of white pack ice was just visible on the horizon from where we stood, some 800 to 900 feet above the sea. Large sheets of ice were still going out and drifting to the north, and the migration of the Emperors was in full swing. There were again two companies waiting on the ice at the actual water's edge, with some hundred more tailing out in single file to join them. The birds were waiting far out at the edge of the open water, as far as it was possible for them to walk, on a projecting piece of ice, the very next piece that would break away and drift to the north. The line of tracks in the snow along which the birds had gone the day before was now cut off short at the edge of the open water, showing that they had gone, and under the ice cliffs there was an appreciable diminution in the number of Emperors left, hardly more than half remaining of all that we had seen there six days before.

The following day, the 24th of October, we were again confined to our camp and sleeping bags with a very heavy blizzard from the south, but on the 25th, we made an effort to reach the edge of the cliffs, and saw once more this method of migration going on. There was again on the extreme edge of the fast ice a large number of waiting birds, and a long file of others going out to join them. I believe that as yet none but the unemployed had gone, for they had all a mile or two to walk to the edge of the open water and all were walking freely; their movements being very different when they have a chick between the legs. The nursing contingent of the rookery was still huddled under the ice cliffs, sheltered from the worst of the storm, but markedly reduced in numbers.

We had ourselves some difficulty this time in regaining our tent, for the storm came on with fury, and the air was so thick with snow that we could see nothing but what was at our feet. We had, as a precaution before starting, laid out a line of ski poles, skis, ice axes and a length of Alpine rope across the direction of our path to help us to again find our tent, but had we not worn crampons, which bit holes in the hard ice and gave us marks to follow, we should have had great difficulty in finding our way back that day or night, for all marks in softer snow were immediately swept away.

The two following days and nights the storm raged with so much drift that we were forced to remain in our sodden sleeping bags, and it was not until the 28th that we were once more able to visit the edge of the overlooking cliff. It was then blowing and drifting so hard that we got but an occasional glimpse of the birds below in the bay. No ice was now to be seen on Ross Sea, even to the very horizon. More ice had left the little bay, and precisely the same exodus was in progress that we had seen before. On the edge of the bay ice, again, a pack of about a hundred birds were waiting to be drifted north, and a file of adults going out from the shelter of the cliffs to join them. There was still a remnant with their chickens waiting under the ice cliffs.

On October 29th we made a day's journey to the Adélie Penguin rookery in most objectionable weather, and on the 30th and 31st and on November 1st we were again forced to remain in our camp by a renewal of the blizzard. On November 2nd the weather cleared, and taking a rope and ice axes we crossed the pressure ridges and once more visited the Emperors down on the sea-ice in their rookery.

Ross Sea was free of ice, and the Emperors then remaining, in all about four hundred, were scattered over the limited area of fast ice still filling up the bay. It was now quite an easy task to number the chickens, for they were lying all around us dead. There were not more than thirty left living in the rookery on November 2nd.

In September, when Lieutenant Royds and I were here together, we calculated that there were perhaps a hundred and fifty chicks amongst the thousand adults. We were therefore in a position to check our estimate, for we could collect into a heap all the dead chickens we found lying on the ice (*see* fig. 23, p. 30). Including the deserted eggs, these numbered just a hundred, making the total for the year's production one hundred and thirty young. This gives the surprising death rate of 77 per cent. Thus :—

| | |
|---|---|
| *September 13th*, 1903—Dead chicks picked up and brought home to the ship | 18 |
| Eggs unhatched and deserted, all brought home to the ship... ... | 20 |
| *November 2nd*, 1903—Dead chicks picked up ... ... ... ... | 63 |
| Chicks still living ... ... ... ... ... ... ... | 30 |
| Total ... ... | 131 |

giving a total of one hundred and thirty-one as the produce for the year, of which no fewer than one hundred and one lost their lives before leaving the rookery for the pack ice.

It was most interesting to note how closely these observations for the year 1903 agreed with those which had been made on the same spot the year before by Lieutenant Skelton. In 1902 Lieutenants Royds and Skelton had been encamped there during a blizzard of five days and, on October 18th, when the storm abated, had gone down on to the sea-ice to take a count of the number of birds and chickens. Skelton's estimate was about thirty living chickens and four hundred adult birds, almost identically the same as in the year that followed.

The blizzard which detained us the following year lasted ten days. Before its

onset we calculated that there were over a thousand Emperors in the bay; when it abated we calculated that there were about four hundred adults and from twenty-five to thirty living chicks. What went on during the storm we were luckily able to see, and what we saw gave us the clue to the sudden disappearance of all Emperors, young and old, from the bay by November 8th, when Lieutenant Royds made his second visit to the spot in 1902. Had we possessed food and fuel enough we should have remained encamped on this spot to see the remnant carry out their migration, but our return to the ship was already overdue and our food and fuel had almost come to an end. So we had perforce to leave and make our way back. We took with us the oldest chicken we could find in the rookery, in case the chick we had left at the ship might have died during our absence, and we hoped that we might soon be able to watch the natal moult in progress. With our departure from the rookery on November 2nd our observations on the Emperor's breeding habits came to an end. No further visits were possible, as all hands on the ship, both officers and men, were requisitioned for the ice saws in McMurdo Sound to cut a channel for the ship's release.

We now, however, knew a good many of the habits of this bird, and they are eccentric to a degree rarely met with even in Ornithology. First, in choosing the darkest months of the Antarctic winter in which to incubate its eggs, which are laid probably in the first week of July. Then, not only in the choice of season for its nesting, but of place. It must needs lay its single egg upon sea-ice with no pretence at nesting, removing the egg at once from the surface of the ice to rest upon its own feet. There it holds it wedged in between the legs closely pressed to a patch of bare skin in the lower abdomen, and covered from exposure to the cold by a loose falling lappet of abdominal skin and feathers.

That this method which the King, in common with the Emperor Penguin, has of holding the egg on its feet, covered up by what is nothing but a fold of abdominal skin, should ever have been described as the "pouching" of its egg is much to be regretted. The term "pouch" is wholly misleading in this connection, not only anatomically but from a purely descriptive point of view. There is no pouch of any sort or kind into which the egg is placed, it is merely held upon the feet to keep it from actual contact with the ice or ground, and covered up by a loose and thickly-feathered fold of skin to keep it warm (*see* fig. 8, p. 14; also figs. 9, 10, p. 16).

On the sea-ice, therefore, the Emperor stands waiting for the egg to hatch. But as there is no such thing to be found in September as a bird half-starved or in poor condition, all being fat and in perfect plumage, it is obvious that the same bird does not sit on the same egg for seven weeks. It would appear that the incubation is carried out not by one bird only, nor by a single pair, but by a dozen or more, which stand patiently waiting round for a chance to seize either a chicken or an egg as the post of incubator becomes vacant; every adult bird, both male and female, in the whole rookery has a keen desire to "sit" on something. Certainly not more than one egg, and so one chicken, is produced to every ten or twelve adults, though why this should be the case is

more than one can say ; possibly it is a condition of things evolved in an exacting climate, to allow each adult to obtain sufficient food through so long a period of incubation.

Not only do the barren females take their turn with the hens that lay the eggs, but the male birds also help, and so every individual, whether male or female, has the same bare patch of skin in the median line of the lower part of the abdomen against which the egg is closely held for warmth. What we actually saw again and again was the wild dash made by a dozen adults, each weighing anything up to 90 lbs., to take possession of any chicken that happened to find itself deserted on the ice. It can be compared to nothing better than a football "scrimmage," in which the first bird to seize the chicken is hustled and worried on all sides by the others while it rapidly tries to push the infant in between its legs with the help of its pointed beak, shrugging up the loose skin of the abdomen the while to cover it. Although the transfer of the *egg* was never actually seen, there is every reason to believe that when the sitting bird feels hungry it hands over its treasure to the nearest neighbour that will undertake the duty of incubation.

That no great care is taken to save the chick from injury is obvious from an examination of the dead ones lying on the ice. All had rents and claw marks in the skin, and we saw this not only in the dead but in the living. The chicks are fully alive to the inconvenience of being fought for by so many clumsy nurses, and I have seen them not only make the best use of their legs in avoiding so much attention, but even crawl in under a ledge of ice where the old birds could not follow them, and there remain to starve and freeze in preference to being nursed. Undoubtedly, I think that of the 77 per cent. that die before they shed their down, quite half are killed by kindness. Once caught and tucked away the chicken appears to be very comfortable, but the process of changing hands, which must take place fairly often, is full of danger. Often enough the chick is almost smothered by the struggles of the heavy birds above it; often enough, too, its skin is torn by beak and claw, and from time to time it will be found to have dropped down a crack in the ice, where it remains to freeze in the sludge while the birds dispute its possession just above, not one of them having the sense to help it out of its dangerous position. It is not wonderful, therefore, that a very large proportion come to grief, and the season of the year in which the unhappy chicken is forced to emerge from its egg-shell undoubtedly tends to increase the enormous death-rate.

A glance at the mean temperatures for each month of the year in this region (*see* pp. 117 and 118) will show at once that the Emperor Penguin chick which is hatched at the end of August has to face, in the first few weeks of its life, the lowest temperatures of the whole Antarctic year. The mean of the two Septembers of 1902 and 1903 was $-12°$ F. and $-18{\cdot}7°$ F., and thermometers within a few miles of the rookery in that month recorded $-63°$ F. and even $-68°$ F. upon the Barrier.

The question that naturally arises from an infant mortality of 77 per cent. is whether or no the breed of Emperor Penguins is dying out. From all that we saw and from all

Fig. 6. Emperor Penguins Beginning to Moult.

Fig. 7. Emperor Penguins in Full Moult.

*To face p.* 12.

that has been recorded of the wide distribution and comparatively frequent occurrence of this bird, I should myself say most certainly not. It is to be met with all over the Antarctic region. The fact of the death-rate being high at the only rookery as yet located, a rookery which was situated almost as far south as the bird has ever been known to wander, even in the summer months, does not necessarily prove that it would be as high in every other rookery. There may be certain conditions at this spot, local and climatic, which would account for an extra high mortality, or it may be, as I have already suggested, that the bird has a great longevity and that this to some extent counteracts the effect of a high rate of death in infancy.*

A very pathetic sight was to be seen, resulting from the intense desire of the unemployed adults to "mother" something. Having neither eggs nor living chickens they are reduced to mothering the dead, and so it was no uncommon thing to see an old bird trying to coax a frozen infant into a comfortable position between its legs, or to see the head and neck of a lifeless chicken trailing out behind by the old bird's tail. To such an extent was this practised that very few of the chickens found dead upon the icefloe were in a fit condition for making specimens. The down was in most cases worn by friction from off the stone-hard frozen body, and the legs and wings were in the majority of cases broken. Were it not for the interest attached to these mutilations as proof of one phase in a unique life history, few of the specimens found dead would have been worth preserving. As it was, however, we brought a number of them home.

As the size of the chicks increased, the difficulty of covering them up with the flap grew greater, and when we visited them on the 19th of October we saw quite a number in which the head and shoulders alone were out of sight, the large round hinder quarters covered with greyish down sticking out behind, surmounted by a short black tail.

Sometimes the chick would face the same way as the parent, and then but little of its anatomy was out of sight, for the main increase in bulk was in the lower third of its body, till the little individual became almost pyramidal in shape. The legs and feet of the chicks soon became comparatively coarse and heavy for their size. They certainly need to have them hard and horny, living as they do on the old bird's scaly feet; neither would it do them any harm to have the parts around the anus also horny, for in some cases these parts were so abraded as to be raw and bleeding.

The usual position taken up in the earlier stages was a crouching attitude with the head as low as the feet, and it appeared to make little difference whether the chick sat upright on its nurse's feet or lay upon its side. The chicks when quite small are invisible so long as the nurse keeps still, but have the power, and use it frequently, of poking the head out from beneath the flap to look about and whistle for more food.

* Prof. Bell has kindly obtained for me, from Mr. Herbert Klugh, the following estimate of the age of an Emperor Penguin so far as it may be deduced from the foregoing facts. "Assume that after the chick stage all the birds in the rookery live to the average age $a$ and then die, then there must be $\frac{1,030}{a}$ of every age; and so every year $\frac{1,030}{a}$ die, so that in order to keep the population stationary, if $\frac{1,030}{a} = 30$, the average age $= 34\frac{1}{3}$ years."

If one forced an old bird with a chicken to move, it would shuffle along awkwardly as though the feet were tied together, never exposing the chicken or changing from a plantigrade mode of progression. If one hurried such a bird a little more, it would over-balance forwards, and try then to retain the chicken with its feet, helping itself along with beak and wings. If still pressed to move rapidly, the feet were involuntarily brought into action, and the chicken very soon slipped out behind, being left sprawling and piping in the open on the ice to be pounced upon by the nearest unemployed adults without delay.

Obviously, the chickens, as I have said, are common property, and they must change hands scores of times while they are dependent upon the adults for their food. The method of feeding was precisely as described below in the case of the Adélie Penguins. The old bird, having regurgitated some semi-digested food into its pharynx, allowed the chicken to supply itself from there by poking its head and bill inside the parent's mouth.

The food of the Emperor Penguin consists mainly of fish and cephalopods, the bones and the horny beaks of which are constantly accompanied by pebbles in the stomach. Crustaceans of various kinds are eaten as well as fish, but the latter seem to form the bulk of their ordinary diet. That so many large birds are able to find food for themselves in those southern waters, even in the depth of winter, proves conclusively that there is a great abundance of marine life under the ice throughout the year. This, in the case of such animals as Crustaceans, Medusæ, Asteroids and Hydrozoa, was amply proved by the collections made by Mr. Hodgson, but that fish were so abundant we knew mainly by the contents of the stomachs of seals and penguins.

It may seem strange, that during the winter months the sea was not so completely frozen over as to prevent the penguins from entering it every day, but so it was just where they congregated.

Floating ice drifts in a direction dependent upon wind and current. If the mass is very large, *e.g.*, an iceberg, having about seven times the visible bulk submerged, the direction of its movement will depend almost wholly on the ocean current, and one may constantly see icebergs travelling up the wind. But with flat sheets of ice, such as are formed by the freezing of the sea in winter, the wind has often a greater directive force than the current of the water. Consequently, along the sea face of the Great Ice Barrier, where not only is the set of the water current northerly, but the wind as a rule is southerly or easterly, the two combine to keep the sea ice on the move in a north-westerly direction, producing, for the greater part of the winter, a lane of open water along the actual foot of the ice cliffs. Of this the Emperor Penguins take advantage, and here they have an entrance to open water always handy.

If, as very occasionally happens, there is a northerly wind of any strength, the sea-ice is driven up to the foot of the Barrier ice cliffs, the channel is for the time being closed, and the birds are forced to look for cracks and seals' holes by which to

Fig. 8. Emperor Penguin and Chick.

*To face p.* **14.**

enter the water for their food. Probably during the whole winter there is never a day on which a mile or two of travel on the ice would not bring them to an opening of this kind.

If, again, the set of the ice drift be easterly, there will be an open pool of water under the lee of every cape along the ice cliffs ; and, *vice versâ*, if the set be westerly, there will be pools on the eastern side of all the bigger capes ; and one realises, on skinning an Emperor Penguin, that the very substantial layer of fat beneath its skin, quite indispensable in such a climate, can only be maintained by a constant and abundant take of food at all times. The season of the year when this layer of fat is most ample is, as one would expect, toward the end of the summer months and before the moult, when the new feathers underneath the skin will be found embedded in a mass of fat at least an inch in depth all over. This layer is much reduced by the growth of the new feathers and by the period of starvation necessarily undergone during the moult, when nothing will induce the birds to enter the water.

The fish which forms the Emperor Penguin's staple diet is a small silvery species of from 4 to 6 inches in length ; the crustaceans were mainly *Euphausiæ* and schizopods, while the cephalopods were of considerable size, a foot or two in length judging by their beaks. The pebbles were no doubt of use in the trituration of the fish bones and the harder parts of the crustaceans' shells. They were always present, in the young and in the old, and were found even in the stomach of a chick which could only have emerged from the egg a day or so before. Exactly where the pebbles come from is not at first sight evident, seeing that the birds are never seen on land. Probably they are picked up at the bottom of the shallow seas, or some of them may be found on floating glacier-ice. Much grit and gravel, even of a considerable size, is blown some distance on to sea-ice from the neighbouring coast-line. It may be that this affords the birds the supply they need. Occasionally the stones are passed with the excreta, and may be found in the radiating pattern which is left upon the ice floes where a company of Emperor Penguins has huddled together for warmth and rest in their spring and autumn wanderings.

These wanderings are worthy of a note in passing. We had settled into our winter quarters on February 8th, 1902, and had seen no Emperor Penguins there at all, until, on March 30th, we were surprised by a party of twenty-eight, whose tracks over the ice showed that they had wandered very irregularly along re-frozen cracks, endeavouring to find some place where they could enter the water. They kept well together always, travelling in single file, now and again halting as mentioned above to huddle together in a heap, all facing towards a common centre, presumably for warmth and sleep. Occasionally the tracks showed that a bird had preferred to travel on its breast, but as a rule they all were walking.

No bird was then seen till the 8th of April, when again a party of between thirty and forty appeared in the darkness near the ship. Of these we caught and killed a large number, and one was the heaviest so far recorded, scaling 90 lbs. The

sea-ice, however, was breaking up and we were unable to follow their tracks to find out where they had come from. On April 12th, four days later, we again saw a party of five, and on the 13th seven more; on the 19th a single one, and on the 6th of May two others. These were the last for the season, and no doubt by this time, so close to mid-winter, they had collected together at their various rookeries to commence the duties of mating and incubation.

The next that were seen in McMurdo Sound were wandering on the ice not far from open water in the spring. Here one might find them about the middle of September in small companies, and in the best of plumage and condition. They seemed then rather to prefer our company than otherwise; and a party of fifteen on one occasion followed us for some distance. Always full of curiosity, they would stand round in a group making comments to one another on our appearance. They had no objection to being photographed, but resented being stroked. Such a group formed an exceedingly beautiful picture; their lemon-yellow breasts shone like satin in the sun, and their bluish backs and jet-black heads set off the golden yellow patch on the side of the neck, and the rose or lilac streak on the lower bill. The back and breast, if the bird had just been in the water, would glitter with crystals of ice and salt. No doubt the brilliance of such a picture was much enhanced by the fact that we were just emerging from the darkness of a polar winter, during which we had seen no sun for seventeen weeks. But still, such is their size and colouring that they would form a striking feature anywhere.

We saw again on September 29th a party of forty-six Emperors, and two parties of eight and twenty on the following day, and so on through the early summer months. How, in the light of ascertained facts, these birds came to be wandering in the spring, when they should have been at the breeding colonies, one cannot understand. Perhaps, having lost their own young, or having produced no eggs, they got sick of waiting about on the off-chance of nursing the young of another bird, and began to wander for want of better occupation. There were both males and females in these companies, as we found by taking samples from their number. Sometimes we chose out the largest and the smallest; the latter has proved to be a female, the former a male, though it is certain that size is no criterion in distinguishing the sexes, for the record individual of 90 lbs. weight was a female.

The average weight of thirty-three of these birds, all of which were adults and in full plumage, taken in November, was 70½ lbs. Only one was below 60 lbs., scaling 58½ lbs. Fourteen came between 60 and 70 lbs., fourteen between 70 and 80 lbs., three weighed respectively 80, 80, and 87 lbs., and one scaled the record weight of 90 lbs. These measurements were kindly taken for me by Lieuts. Royds and Skelton.

Their method of progression varies much with the necessity for speed. When left to themselves the birds invariably walk bolt upright with great dignity (*see* fig. 12, p. 18); but if alarmed in any way immediately drop down on to the breast and toboggan rapidly along by alternating strokes of their powerful legs and wings. If overtaken in their

FIG. 9. EMPEROR PENGUIN AND CHICK.

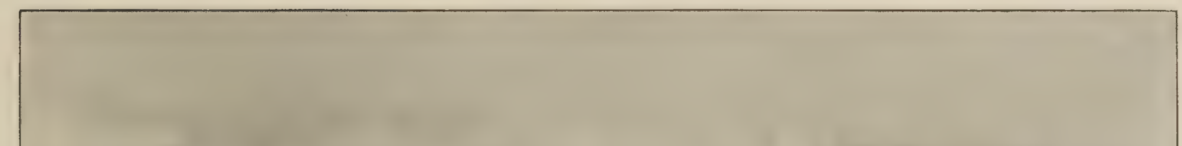


FIG. 10. EMPEROR PENGUIN AND CHICK.

*To face p.* 16.

efforts to escape the birds will at once rise to their feet and show fight, facing their antagonists and using bill and flippers simultaneously, and the stroke of an Emperor Penguin's wing, if caught fairly on the hand or on the shin, leaves a bruise which will be felt for many weeks.

When pressed to travel as fast as possible they glide along on the ice at the rate of about 8 or 10 miles an hour (*see* fig. 11, p. 18). This rate is, of course, much exceeded in the water, where their speed and dodging power probably rivals that of fishes, seals, and whales. They swim with their wings, and may often be seen to leap from the water and land upright on a shelf of ice at least four feet above the surface. Their only enemies, so far as is known, are also inhabitants of the water; and their ideas of fear are connected chiefly with that element, as in the case of Adélie Penguins.

We once found the ragged skin of an Emperor Penguin in the stomach of a 12-foot Sea Leopard (*Stenorhinchus leptonyx*), and this seal has been known to take Adélie Penguins (*Pygoscelis adeliæ*) in the water as they were thrown to it from the ship. There is therefore no doubt that the Sea Leopard is one of the Emperor's active foes. Probably none of the other seals would attempt to molest it; but the Killer Whale (*Orca gladiator*), whose food is seal and dolphin, would almost certainly take Emperor Penguins if they came in its way. This however we did not see; nor did we anywhere come across another dead Emperor Penguin, except on one occasion, when the mangled skin of an adult bird turned almost inside out floated past our ship as we entered McMurdo Sound. Probably it was the remains of a bird which had died and had formed a feast for some Skua (*Megalestris maccormicki*) or Giant Petrel (*Ossifraga gigantea*). Neither of these birds, however, should be considered the natural enemy of the Emperor Penguin, for I do not believe that this Petrel attacks things living, as a rule; nor has the Skua any opportunity to attack the Emperor Penguin's chickens, since at the time of their infancy, in the winter and early spring, they are many hundreds of miles to the south of the region then infested by the Skuas.

The Emperor Penguin sleeps either standing in the upright position with its head turned back over the shoulder so that the tip of the beak rests under the back of the wing (*see* fig. 14, p. 22), or else in the prone position with the head drawn in upon the neck. The positions assumed by the chick are seen to be slightly different (figs. 19, 20, p. 26). Both attitudes are to be seen in the photograph taken by Lieutenant-Engineer Skelton (fig. 5, p. 8). Whether the former posture is a relic of days gone by, when the bird had a fully feathered wing and was capable of flight, it is not easy to say; but it is suggestive to see it take up an attitude which would have been comfortable when it had thick warm feathers into which to breathe. It may be that the position is merely a convenient one for balance, and it is quite certain that all comfort must have disappeared since the wing became converted into a bony flipper. The prone position is certainly more reasonable with a view to economising body-heat. Both attitudes are assumed by the chick in its earliest stages when taken from the adult.

The temperature of the bird is high, but not so high as that given by Mr. Eagle Clarke, as observed in the Adélie Penguins by members of the Scottish Expedition. For that bird the temperature is given as 106° Fahr., but in the Emperor, as a mean of that taken in the œsophagus and in the rectum the moment after pithing a fresh-caught bird, we found the temperature to be 100·7° Fahr. The rate of the pulse in a "pithed" bird was sixty to the minute, and the respiration in a chicken twenty. It is possible that the damage to the medulla may have affected these observations, though they were taken the moment after; it was not easy, however, to make them otherwise.

There were no parasites discoverable on the skin or amongst the feathers of the Emperor Penguin—a fact which is somewhat remarkable, and one which holds good, so far as we were able to make out, for all Antarctic birds and beasts, in direct opposition to the experience of observers of Northern Polar birds and animals. The only typical Antarctic bird on which lice were ever discovered, and in this one case they swarmed, was in a single individual of the Snow Petrel (*Pagodroma nivea*). Bacteria, I am told by Dr. Koettlitz, infested the intestines and also were discoverable in the incubated eggs of the Emperor Penguin.

The cry of the adult Emperor is far louder, more prolonged, and more musical than the harsh croak of the Adélie Penguin. It is like a defiant trumpet-call, and can be heard at a great distance over the icefloes. This is its rallying call note, and is emitted with the head erect, but it has also a clucking or chattering note to which it gives expression in a different way. Bending the head and neck down low on the breast in a powerful expiratory effort, it then, in raising it, gives vent to an interrupted musical cry as the lungs are filled with air. The supraclavicular hollows can be seen distinctly emptying as the head goes down, and filling out again as the head is raised. The cry of the chick, which is noted elsewhere, is a more definite utterance of four notes emitted in the same way, and bearing a faint resemblance, according to our worthy bluejackets, to the words, "Gimme some more, gimme some more," which it at any rate always implied exactly, even if the resemblance was somewhat vague.

The bird occurs probably throughout the whole of the Antarctic regions within the limits of the ice, or more exactly, as laid down by Mr. Howard Saunders in the "Antarctic Manual," it "ranges longitudinally from 151° E. in Victoria Quadrant, through Ross Quadrant, to about 50° W. in Weddell Quadrant." Its range to the north has been somewhat extended lately by the Scottish Expedition, some of whose members saw an immature example of the bird in 60° 44′ S. lat., where the 'Scotia' wintered in the South Orkney Islands. The limit of its range to the south coincides with the open water of summer, and this in Ross Sea is about 78° S. lat.

The occurrences of the adult bird in the area we ourselves explored are given incidentally throughout the course of this paper, but concerning the immature birds, five or six months old, it is noteworthy that of the ten Emperor Penguins sighted in the pack ice between January 2nd, 1902, and January 8th, 1902, all that were near enough to be distinguished were in that stage of immaturity, and five of


FIG. 11. EMPEROR PENGUINS TOBOGGANING.


FIG. 12. EMPEROR PENGUIN WALKING.

To face p. 18.

them were captured. Furthermore, not one of this age was seen or captured later or in any other region but the pack; though of the immature stage of seventeen months, with the brown and weathered coat, and whitish throat, we saw about five examples in all, and every one of these was taken a great distance farther south, at the edge of the fast ice, and at the end of summer (in February) when the pack-ice belt had disappeared, throwing Ross Sea open to the southern oceans.

It appears, therefore, that the various ages have each their own particular range during certain seasons, and that whereas the pack ice is regarded as a safe nursery for the youngest birds in summer, the more advanced immature birds, which, at seventeen months, are then on the point of moulting, wander south to find fast ice on which to remain while the process lasts, knowing that in the disintegrating ice-pack they might be forced to take to water when it would be highly inconvenient for them to do so.

Similarly, the adult birds, having finished all their duties to the young, now leave them to themselves, and also retire southward in January and February to take up their retreat and moult in safety on fast ice. This accounts for the groups we met in full moult on January 15th, 1902, in the secluded bight known as Lady Newnes Bay; also for the multitude we saw on the fast ice of King Edward VII.'s Land on January 31st, 1902, and for the various examples taken in January, 1903, and in February, 1904, all in full moult or with the moult but just completed, in McMurdo Sound.

We have therefore substantiated the following facts: first, that the Emperor Penguin chick remains but four months in the down, a most astonishing fact, if, as seems to be case, the King Penguin chick remains in down for fully ten months (see pp. 34, 35); that it then moults to assume the blue-grey plumage with the whitish throat which characterises the birds of five months old to be found in the pack during January. This same plumage is to be seen a year later in a brown and faded state, with blackish feathers sprinkling the white throat, and the whole about to be shed, in February, when the bird dons the first adult plumage, and all the characters of the fully adult, though not as yet the richness of colouring that it will assume at the next annual moult.

One immature bird was brought on board in Lady Newnes Bay, and kept in captivity while it shed its immature and donned its adult plumage. The feathers clinging close to one another came off in spurious sheets or handfuls, first from the breast and thighs, and then from the face and tail and flippers, but most irregularly, until at length there was nothing but a ruffle or collar of old feathers round the neck (*see* fig. 15, p. 22; and figs. 6 and 7, p. 12). This moult took just twenty days from start to finish.

It has before been stated, as a result of the late Nicolai Hanson's observations in the 'Southern Cross,' that the birds fast while moulting and avoid at all costs entering the water.

The young feathers embedded in a mass of fat beneath the skin grow rapidly, and push the old ones out, so that often a mere touch will detach a hundred feathers from the bird *en masse*, giving the false impression that they have come off

in a sheet or "slough," and suggesting a comparison with the sloughing of a reptile's skin. The comparison, however, as Mr. Pycraft has elsewhere shown, is fallacious, and as misleading in its suggestion as the use of the word "pouch" in describing the same bird's incubation methods.

In all probability, not only are the superficial scales of the feet shed as well as the feathers, but also the plate on either side of the lower mandible, as in the case of the Puffin and possibly the Auk * and other birds. The superficial layers of these horny parts, at any rate, become loose, and, in the Emperor, change the colour of the beak, rendering it dull and opaque, and the feet brown instead of black. The coloured plates of the lower mandible can easily be removed in a moulting bird, and are then found to be of a translucent yellow horn.

In the young chick the colouring of the iris is a rich dark brown, varying a trifle in warmth from dark walnut, though never reaching the redness of mahogany. The bill is blackish at the tip and base and whitish in the centre, while in the older chicks there is sometimes a faint dusky purplish tinge in the lower bill. The feet and nails, at first pale fleshy grey or the colour of French chalk, become darker day by day, till in the third week they are definitely black.

In the immature bird, after shedding the downy feathers, the whole of the back becomes bluish grey, the blue tinge preponderating and encroaching on the head and neck. The chin is grey and mottled, but the throat, instead of being black as in the adult, is white, with here and there a greyish feather showing through, though in some the demarcation line between the dark chin and the white throat is quite distinct, as in Fig. 3 of Birds, Plate III. If this figure be examined and compared, first with the arrangement of black-and-white in the chick, Figs. 1 and 2, Plate III., and then with the head represented in Fig. 4, it will be seen to show a kind of transition stage in which the white round the orbit in the chick has not quite changed to the dark grey characterising Fig. 4, Plate III. Neither has the grey patch on the side of the neck, the precursor of the orange in the adult, come out so prominently in Fig. 3, Plate III., as it has in Fig. 4, Plate III. This is due to a variable admixture of grey feathers with the white and white with the grey, as the case may be. The iris in this stage also is a rich dark brown, and the bill has become dusky throughout, with a dull purple tinge upon the lower mandible. The feet are black, as also are the claws; this holds good for the adult bird as well. The beak, however, alters, and in Figs. 5 and 6, Plate III., it will be seen that the side plates of the lower bill now show a decided orange yellow tint, less marked than in the fully adult bird, but still distinct. These two heads are drawn from birds in the same plumage as Nos. 3 and 4, Plate III., but after a full year's weathering, which has faded the black to brown and has much reduced the prominence of the blue or bluish grey. The whole plumage in this stage has a brown and faded appearance, and the patch on the side of the neck has become quite white. In No. 6, Plate III., the demarcation of the black throat of the adult is already

* Puffin = *Fratercula arctica*; Auk = *Mergulus alle*.

definitely marked by the appearance of a few black feathers. On this plate then are represented the heads of three distinct phases of plumage, Nos. 1 and 2 giving the heads of chicks in down in the first 4 months, Nos. 3 and 4 giving the heads of immature birds at 5 months and onwards; this gradually weathering to the condition of the heads figured in Nos. 5 and 6, which are drawn from birds of 18 months, when they are on the point of moulting for the first time into the black-throated, yellow-necked dress of the adult.

The first adult livery is, as I have said, not quite so rich in colour as it becomes after another moult, but is in other respects similar, and so has not been figured. Plate II. represents the life-size head of an adult Emperor in full plumage, with the rose and lilac colour fully developed on the lower bill, and the head and throat a rich glossy black against the bright orange yellow on the neck. Had the weathered and faded condition of the adult livery been represented, it would have shown again how much of the black fades out to a dull brown colour, both on the head and neck and back, the blue hardly changing, but giving with the brown a very faded appearance to the plumage. The tail feathers, twenty in number, become worn to mere quills, and often in the breeding rookery one may find all the tail feathers detached from the bird and lying imbedded in a large lump of hard and dirty ice upon the floe. The scales on the feet also will be no longer a rich black, but brown.

If one compares the measurements of the birds in these various stages of growth, one finds that great changes are effected in the bill. It will be seen by comparing Figs. 3 and 4 with Figs. 5 and 6 of Plate III., that the chief alteration takes place by the lengthening of the upper mandible, the curve of which gradually increases. With this growth proceeding at a faster rate along the culmen than along the tomia, the nostrils, which are very definite and well marked in the first few months of life, gradually become obscured. So also the thickening, which is apparent on the culmen about one-fourth of its length from the tip, is also gradually obliterated by the elongation of the upper mandible. This thickening has served in place of an egg scale, which is not developed as a deciduous element at all. The angle of the gonys, too, which is quite apparent in the lower mandible up to the fifth month, gradually disappears with the lengthening of the bill, and eventually the strong uniform curve of the adult bill developes to its full extent.

Perhaps the measurements which best bring out these changes in the growth of the bill are the length of the upper mandible from the feathers at the nostril to the tip, and the measurement from the angle of the mouth to the tip of the bill. Thus:—

| | Nostril to Tip. | Gape to Tip. |
|---|---|---|
| At 5 months ... ... ... | 3·5 cm. ... ... ... | 8·1 cm. |
| At 18 months ... ... ... | 4·3 cm. ... ... ... | 9·3 cm. |
| At 20 months ... ... ... | (broken) ... ... ... | 10·5 cm. |
| At 30 months and onwards ... | 4·5 cm. ... ... ... | 11·8 cm. |

The adult measurements of the wings are reached much earlier, even within the first six months, as also are the measurements of the feet and claws, presumably as a

result of the necessity for extra strength and efficiency in those parts to avoid natural enemies over and above their uses in obtaining food, while the bill lacks this stimulus to rapid growth.

The individual variation to be found in a series of Emperor Penguins amounts to very little indeed. When the variation in size and weight has been mentioned, as illustrated in the series of thirty-three birds given above, there is no special point to which attention can be drawn except in the curve of the bill. Here, however, there is some variation having no apparent reference to sex or age. In some individuals the curve is decidedly more marked than in others, as may be seen, for example, in the two birds of a similar age in Figs. 5 and 6 of Birds, Plate III. This is not merely characteristic of immaturity, for the curved type shown in Fig. 5 is found even more strongly marked in some of the adult specimens in the collection.

The colour of the side plate of the lower mandible is also variable, from yellow through orange and red to lilac; but it seems to depend to a certain extent on the condition of the peripheral circulation, turning to a livid lilac when the circulation is depressed by cold. The depth of the lemon-yellow colour of the breast and abdominal feathers varies considerably according to the extent to which the summer sun has faded it. When freshly moulted the whole of the lower parts must be described as pale lemon yellow, not white, as in the catalogue of the British Museum.

In describing the immature bird also there is a point worth noting in the colour of the crown, which is of pale bluish grey, marked off as a distinct patch from the darker grey which surrounds it. This bluish patch is noticeable during the first seventeen months, but the head then becomes jet black all over. The point is the more interesting because it is exactly reproduced in the first prenuptial plumage of the immature King Penguin. As a grey coronal patch it is lost in both King and Emperor when the immature plumage is discarded, but in the King the tendency to differentiate in colour in this part of the head is again brought out by the deposition of minute quantities of golden yellow pigment in the coronal and particularly the superciliary feathers, which with the black gives the crown a greenish sheen. This is also to be seen upon the chin and throat. That this tendency to deposit golden yellow pigment should occur in the position in which the golden superciliary crests occur in *Catarrhactes* and *Megadyptes* is most significant, and an examination of a specimen of the King Penguin in the collection of the British Museum, now figured for the first time in Fig. 4 of Birds, Plate VIII., will show how far this tendency may be carried in a particularly vigorous individual.

Attention is particularly drawn to the distribution of the golden yellow pigment in this specimen, because it has a definite bearing on the genesis of the superciliary crests in those genera which normally possess them. To this end I have gone into some detail in describing the head and neck of this particular specimen in the chapter devoted to *Aptenodytes patagonica* (pp. 35, 36), and there the question of its relationship to *Aptenodytes forsteri* is dealt with more fully.

Fig. 13. Emperor Penguin Rookery at Cape Crozier.

Fig. 14. Emperor Penguin Sleeping.

Fig. 15. Emperor Penguin Moulting, the last feathers to drop off.

To face p 22.

The most puzzling fact about the Emperor Penguin is that the colouring of its nestling is totally different from that of the nestling of the King. Previous to its discovery in 1902 it would have been deemed reasonable to surmise that the chicken of the Emperor when found would be uniformly dark brown in colour and hardly distinguishable from the chicken of the King. But this is far from being the case. In direct contrast, it has a jet-black head with a pure white area surrounding each of the eyes. The black of the head starting from the base of the upper bill, and including the forehead, lores and chin, is continued over the crown to the nape of the neck. There it blends with the silver grey of the back, to be continued as a grey or blackish band, almost, but in most cases not quite, meeting on the fore neck as a collar. Between this collar and the chin, which is jet black, the throat is pure white, as is also a rounded area including the cheek, eyebrow, and ear coverts. The minute little tuft of stiff feathers which constitutes the tail is jet black, and the whole of the remainder of the down covering the body is silvery white or grey, with this notable peculiarity, that the darker area is on the under surface, extending from the fore neck to the vent, over breast and abdomen, whereas the whiter area is on the dorsal aspect including the nape, mantle, scapulars, back and rump, as well as the minute and downy-coated flippers, thus reversing the usual order, in which the under parts are lighter, or at least not darker than the upper (figs. 16, 17, p. 24).

The complete absence of any protrusion of the brow or superciliary prominence gives the bird a quizzical look which is always entertaining. The movements of the eye are quick, and the upper lid is raised to look upwards without much motion of the head. The outer coverings of the eye are almost flush with the outer contour of the face and head; there is no attempt to offer it protection by bony ridges, but every effort is made to produce an eye so placed as to catch the glint of a fish above, below, ahead or astern, while the bird is in its element under water in search of food.

I have so far been unsuccessful in finding any discernible reason for the peculiarities of colour distribution to which attention has just been drawn. That at one period the adults of the Emperor and the King must have been totally distinct one has every right to conclude from the fact that the chick of the one is uniformly dark and brown, while the chick of the other is a fantastic piebald of black and white. Yet the adults have such striking similarities in their jet-black heads, their orange necks and beak plates, their bluish backs and lemon-yellow breasts, that one is led to consider them close relations to one another until their chickens are examined side by side. Even then one is reminded that the Emperor Penguin and the King Penguin lay but one egg each, and that both incubate the egg in the same way on the dorsum of the foot instead of in a nest. This they do moreover in an upright position instead of squatting on the egg as do other penguins. It is impossible to think that these many peculiar similarities have been developed independently by birds which were once more distinct, but how then can one explain the total dissimilarity that exists now in the chicks? The simplest way out of the difficulty would be to say that the white down of the Emperor's

chick is a special development for its protection while lying on the snow-covered sea-ice which forms its earliest nursery, but this explanation is by no means borne out by facts. From September to December the chick exists on the floes of the sea-ice upon which it was hatched without ever entering the water. Its enemies, therefore, in the Antarctic can only be other birds. There are no seals that would disturb these chicks on the ice, and the only birds that might interfere with them are the Skua (*Megalestris maccormicki*) and the Giant Petrel (*Ossifraga gigantea*). Both, however, are migrants and neither would appear on the Emperor Penguin's breeding ground until the end of October, some two months after the chickens have left their eggs, and when they would already have reached the size of a full-grown Skua.

I do not believe that the Skua is responsible for the death of any of the Emperors' young, neither do I believe that the white down is the result of a need for protection from any enemies that we know as yet.

The Giant Petrel might occasionally attack the young of the Emperor Penguin, but as far as our own and all other observations go, they lead one to look upon the Giant Petrel as a carrion-feeder with little tendency to attack living animals. It must also be remembered that, like the Skua, the Giant Petrel is far to the north at the outskirts of the pack ice in September and October when the Emperor chicks are in their most helpless state, and that they come southward only with the southward migration of the Adélie Penguins in October.

It may be said that the Sea Leopard (*Stenorhinchus leptonyx*) is a danger to the Emperor Penguin's young, and this seal certainly feeds on full-grown Emperors, but these must be attacked and caught in the water, where the Sea Leopard is probably one of the fastest animals of the south. There is little reason to think that he would attempt to catch such an active animal as the Emperor chicken on an icefloe, where his own pace is slow and his movements clumsy, and where he may be seen sunning himself in friendly neighbourhood with other seals and penguins, none of which fear him on the ice.*

It is obvious, therefore, that the white colouration of the Emperor chick has in this case nothing whatever to do with the theory of protective assimilation. The young bird while in the down is careful never to leave the ice, and there can be no reason to think that it requires any protection other than its parents can give it until it sheds the white down and takes on the dark grey plumage of the first year's bird. This makes it still more difficult to supply a reason for its colouration. As a matter of fact, anything more conspicuous than a jet-black head, such as it has, on a field of smooth sea-ice could hardly be imagined; but the ice of the pack is seldom smooth, and in a broken mass of disintegrating floes where every piece has others forced upon it, and the movement and wash of the sea has worn them into strange fantastic shapes with holes and hollows, it is easy to see that a white bird would be very inconspicuous indeed, and the more so if its whiteness is helped out by the addition of a black head

* Dr. Pirie states, however, that the Sea Leopard has been seen to come up alongside a floe on which penguins were resting, seize one in its jaws, and sweep down again with its prey, Voy. 'Scotia,' p. 222.

Fig. 16. Emperor Penguin Chick taking its food.

Fig. 17. Emperor Penguin Chicks.

To face p. 24.

to simulate a shadow. But as has already been shown, it probably has no urgent need for being inconspicuous.

We are therefore led to consider whether the black head, which at rest may be an additional help to inconspicuousness, might not be a boon when in motion to the parent, assisting it to find its young after a prolonged stay under water, during which the movements of the ice may have altered all its bearings. This might be considered a partial explanation, but can hardly be the whole of the matter, for the shrill and piping voice of the chick is a very serviceable equipment against such an eventuality as separation from its parent, and again, if a black head is helpful as a beacon, much more so would be a uniformly dark head and body, as in the chicken of the King.

I must confess therefore to an inability to explain the facts of the case in the colouring of this chick, and I am forced to turn for an explanation away from the overburdened theories of protective assimilation, and even of advantageous colouration at all from any but a physiological standpoint. In this particular case, even physiologically, it is hard to see why the Emperor's chick should not have dispensed with the pigmentation of its head, and have done all that was possible to economise its energies by becoming wholly white.

I cannot think that in the adult stage the Emperor Penguin was ever white. The white down of the chick must be a special development of its own, probably upon the lines of physiological economy. Such pigment as it was able to produce instead of being squandered over the whole body, as it is in the young King Penguin, is in the young Emperor concentrated in the head as black, where it may be of use as a signpost to its parent in the pack ice in the manner above suggested. This may on the whole cost each individual less than it would to pigment the whole of the down, and in the September temperatures of the Antarctic even the most trifling effort at physiological economy may turn the scale.

I know that in thus trying to suggest an explanation for this particular case I am falling back on what is still an uncertain theory, but in what has been published concerning the physiological reasons for colour or its absence in various animals, there is sufficient truth to encourage the suggestion of further examples which appear to uphold the theory. In the case of white animals, moreover, whose whiteness is generally due to the absence of pigment in hair or feather, one is on safer ground, for there is no doubt that the production of much pigment is associated with an active tissue metabolism, and that the production of little pigment is associated with a metabolism in which economy is obviously of importance, *e.g.*, old age and winter whitening.

It is possible, moreover, though I know of no experiments that have been made upon the subject, that white feathers and white hair, in which the cellular tissue is occupied by air instead of solid pigment may prove to be a more satisfactory non-conducting material than pigmented hair or feathers. If this is so, we have a definite physiological reason for the whiteness which characterises so many of the Polar animals, and indeed for the whiteness of certain Tropical species, for the conditions which would

in this case be tending to whiteness would be either of the extremes of temperature, and should be better exemplified by Polar and Tropical species than by those of Temperate regions. One other suggestion I would make, namely, that it is an economy to a bird or beast to produce white or unpigmented feather or hair, when such feather or hair has not necessarily got to stand much wear and tear. White feathers undoubtedly wear out far more quickly than pigmented feathers; as, for example, in the moulted primaries of our common Herring Gull (*Larus argentatus*), where the result of wear and tear on pigmented and unpigmented parts of the same feather may readily be seen, and perhaps even better still in the feathers of the Curlew (*Numenius arquatus*) (fig. 46, p. 104).

With the hope of throwing light on the rate of growth of the young Emperor Penguin chickens, we took two on September 13th, 1903, the largest we could find in the rookery, back to the ship.

On September 20th these weighed respectively 636 and 662½ grms. The less heavy of the two, which survived until December 10th, increased at the following rate :—

| | | |
|---|---|---|
| September 3rd, 1903, probable date of hatching, probable weight | 450 | grms. |
| „ 20th ... ... ... ... ... ... ... | 636 | „ |
| „ 27th ... ... ... ... ... ... ... | 889 | „ |
| October 4th ... ... ... ... ... ... ... | 1247·5 | „ |
| „ 11th ... ... ... ... ... ... ... | 1452 | „ |
| „ 18th ... ... ... ... ... ... ... | 1610 | „ |
| „ 25th ... ... ... ... ... ... ... | 1865 | „ |
| November 1st ... ... ... ... ... ... over | 2000 | „ |

(NOTE.—453 grms. = 1 lb.)

We weighed also several others taken on different dates, for example :—

| | | | | | | |
|---|---|---|---|---|---|---|
| No. 16. | Immature in down, found dead. | Sept. 13, 1903 | ... | weighed | 453 | grms |
| No. 1. | „ „ taken alive. | Oct. 18, 1903 | ... | „ | 1698·75 | „ |
| No. 2. | „ „ taken alive. | Oct. 18, 1903 | ... | „ | 1812 | „ |
| No. 3. | „ „ found dead. | Nov. 2, 1903 | ... | „ | 1670·4 | „ |
| No. 4. | „ „ taken alive. | Nov. 5, 1903 | ... | „ | 1245·75 | „ |

The weight of a large egg (No. 34), slightly incubated, was just short of 1 lb. (448·5 grms.).

Probably for the first month or two of its life each chicken puts on rather more than half a pound per week, but in its third and fourth months this average must be largely increased, for in January the chick reaches a bulk equal to about half that of an adult bird, and probably weighs as much as 30 lbs.

The voice of the chick is a very shrill rattling pipe or whistle when it is hungry. First it lowers its head to the ground, craning the neck to its full extent, and then suddenly swings it up as far as it will go, rattling out a very shrill piercing whistle of four notes. It is a crescendo pipe, rising in pitch and in shrillness and suddenly dropping at the end note. Out on the ice in the open air the rookery sounds as though it were full of farmyard chickens. In a confined cabin the noise, even of two

Fig. 18. Emperor Penguin Chick.

Fig. 19. Emperor Penguin Chick, Sleeping.

Fig. 20. Emperor Penguin Chick, Sleeping.

*To face p. 26.*

chicks, is quite trying; and, as they appeared to feel the cold in the observatories on the upper deck, we had to keep our captive chicks below (figs. 21, 22, p. 28).

The result was that, as their foster-parents, we were roused from sleep at least three times every night, and after turning out of a warm bunk, had to masticate seal meat for about twenty minutes each time till the imperious chickens' appetite was subdued. Crushed amphipods were tried, but appeared to have so little food stuff in them that the more solid seal meat was again resorted to. For several weeks, however, before the last bird finally succumbed, it was evident that it was not thriving on this diet, and eventually it died with the bones distorted as in an acute stage of rickets.

It used to be constantly preening its downy feathers, and then, standing upright, would crane its neck and quickly flap its wings backwards and forwards as one sees a young duckling do, making a quaint subdued little crowing noise at the same time (fig. 21, p. 28). The movements of the eyes and eyelids were most peculiar, the eyes being so set in the head of the chick that, without turning sideways, it could see everything above it. Owing to the absence of any eyebrows the cornea was almost flush with the convex outline of the head, which was covered by a very short and velvety down. The legs were set widely apart (fig. 18, p. 26), and with the capacious abdomen and the immense beam of the hind quarters formed a most stable support for the agile neck and for the head, which was shot in various directions with great rapidity, the bird being exceedingly inquisitive and ever ready to peck and worry at an intruding hand.

In feeding it was sufficient to touch the upper bill to make the mouth open widely, the act of swallowing being continued so long as there was any room for more food in the distensible stomach (fig. 16, p. 24). The same wriggling and craning motions that one sees in hawks and owls were used to assist the passage of an extra bulky bolus. The head was then violently shaken from side to side to get rid of adherent pieces or, if necessary, to get rid of an extra bolus which had gone halfway down, but for which there had been found insufficient room below. If it was turned over on its back the chick had very great difficulty in righting itself again.

This particular chicken, as I have said, became very weak and ailing in its third month, and died on December 10th after three months' captivity. It had not then begun to change the down, nor were there any signs of the approach of the natal moult. This in one way was satisfactory, though one would have wished to have kept the bird alive until the moult commenced. It proved, however, conclusively that the chickens had been removed by their parents from the rookery at Cape Crozier when they were still in downy plumage; consequently they could not have entered the water, and the journey must have been undertaken on floating ice, as we surmised from what I have described above in speaking of the migration of the adults.

In general character the egg of the Emperor Penguin approaches that of the King (*see* fig. 24, p. 30). It has the same broadly pyriform shape, but the minute character of the surface is slightly different, not only in the fresh state, but also in such as have been weathered through exposure to sun and wind. The size of the egg varies much, from

measurements which are almost identical with those of the King Penguin's egg to measurements which are almost half as long and half as wide again. The smallest of the series of fourteen eggs procured by our expedition at Cape Crozier measures 10·7 cm. in length and 8·0 cm. in breadth (*see* fig. 1., Pl. VI.); but there are three eggs which measure less in breadth, one being 7·5 cm. across, and the other two 7·7 cm., though their length is in each case greater, namely, 11·0 cm., 11·0 cm., and 12·8 cm. respectively. These figures will give some idea of the variability that exists in the proportionate length and breadth of the eggs, some indeed being long and narrow, and others broad and squat, but all distinctly pyriform. The largest of the series in question measures 13·1 cm. in length, and has a breadth of 8·3 cm. (*see* fig. 1, Pl. VII.), but there is yet another which, though measuring only 12·8 cm. in length, has a breadth of 8·6 cm.

It is therefore clear that there is a wide range both in actual and in proportionate measurements, even in a limited series of eggs from one breeding colony—a fact which may have some bearing upon the age of individuals, if, as I believe to be the case, the younger produce smaller eggs than the older birds. If the age of the laying birds and the size of the eggs they lay increase proportionately, one may argue that where the eggs of a single species vary much in size, there must be a corresponding difference in the age of the individuals; and so, further, that as some of its eggs are nearly half as big again as others, the Emperor Penguin must be a bird of considerable longevity. This, however, is a supposition which can be made only in the form of a suggestion.

It is upheld by very few facts, so far as I can ascertain, from the natural difficulty there is in getting a series of eggs from a single bird of any species from year to year. But in the solitary case of a Buzzard (*Buteo vulgaris*) in which I have seen the eggs laid year by year by the same hen, their size very gradually increased,* and the same observation has been made often enough in the poultry yard with domestic hens.

Previous to our discovery of the Emperor Penguin's rookery at Cape Crozier in 1902 there was but one egg in any known collection which was supposed to be the egg of an Emperor Penguin. This was in the collection of Mr. Walter, of Drayton House, Norwich, and its history, for the details of which I am indebted to him, and to Mr. T. Parkin, of Hastings, is as follows.

It was brought to Paris from the Antarctic in 1838 by the French South Polar Expedition under Dumont D'Urville. In 1840 or 1841 it was bought in Paris by Dr. (afterwards Sir) Henry Alfred Pitman, who sold his entire collection five years later to the late Mr. H. F. Walter, of Papplewick Hall, Notts. At his death the collection passed into the possession of his son, by whom it was removed to Drayton House, Norwich, where the egg in question now lies. This Drayton egg it has been my privilege, through the courtesy of Mr. Walter, to examine and compare with those from Cape Crozier, and I have no doubt now, even if there had been any real doubt before, that it is the egg of an Emperor Penguin. It measures 10·9 cm. in length,

* I have to thank Mr. O. H. Latter, of Charterhouse, for kindly drawing my attention to this series, which is at present in the school museum.

FIG. 21. EMPEROR PENGUIN CHICK, CROWING.


FIG. 22. EMPEROR PENGUIN CHICK, ATTITUDES ASSUMED WHEN PIPING FOR FOOD.

*To face p. 28.*

7·7 cm. in its greatest breadth, and has a surface which provides a certain amount of internal evidence for this belief, as I presently hope to show.

In the account of the breeding habits of the Emperor Penguin, I have stated that the eggs are probably laid in the middle third of the Antarctic winter, that is to say about the beginning of July. Previously, therefore, to the year 1897, when the 'Belgica' first spent a winter in the southern ice, there was no possibility of a fresh Emperor's egg finding its way to England. Neither did anyone on the 'Belgica,' or on the 'Southern Cross' Expedition, claim to have discovered either the egg or breeding place of this penguin. How then could there be any possibility that this Drayton egg was really what it claimed to be? Certainly it could not have been a fresh egg, but it might quite well have been a deserted one picked up on an icefloe by a vessel cruising in the Antarctic during the summer months. It must by that time, no matter what ship found it, have been exposed to some six months' weathering on a floating piece of sea-ice, at a season when the sun shines night and day and is capable of producing thaw and wet where any foreign body could absorb its heat and melt the ice. Here then are the conditions for producing an extremely weathered shell, such as is seen in the Drayton egg. The surface has completely lost its outer chalky covering, and it is worn and smooth except for the minute longitudinal pores that are characteristic of the weathered examples in our own Cape Crozier series. It has very few of the warty excrescences which characterise the majority of the Cape Crozier eggs, but these again are not present in all Emperor Penguins' eggs, nor on the other hand are they always absent in the normal egg of the King Penguin.

In respect of size the Drayton egg is small for an Emperor's, but yet not so small in either dimensions as the smallest of the Cape Crozier series. In length it is 0·2 cm. longer than the shortest, and in breadth it is 0·2 cm. greater than the narrowest of the Cape Crozier series. And if one compares the dimensions of the Drayton egg with the average of a dozen King Penguins' eggs taken at random, one finds it to be 10·9 cm. by 7·75 cm. as compared with 10·1 cm. by 7·36 cm. in the King, and somewhat longer than the largest of a series of King Penguins' eggs which we brought home in the 'Discovery' from the Macquarie Islands in 1901.

There can be no doubt, therefore, that this egg is in reality that of an Emperor Penguin, and that it was brought home from the Antarctic regions by the French Expedition of 1837–1840, some member of which must have picked it up on an icefloe during the summer months of 1837–1838.

But although it gives an idea of the deeper characters of this penguin's egg-shell, the surface of the fresh-laid egg is very different. It is covered in the first place with a thick white chalky concretion, such as is found on the surface of a Shag's or a Gannett's egg.* The colour of the fresh shell has a faint greenish tinge, which is found to be quite a deep green when examined by transmitted light. The surface of the harder shell below is characteristically pitted with a multitude of little longitudinal pores,

* Shag = *Phalacrocorax graculus;* Gannet = *Sula bassana.*

each a few millimetres in length, except where the shell has been secreted in little warty excrescences, forming in some examples a roughness over the whole of the larger end of the egg, but in others appearing only here and there, collected sometimes at the smaller end, sometimes in the middle, and sometimes being absent altogether. In one or two specimens the shell is secreted irregularly, so that raised streaks or faint ridges appear running down the shell from one end to the other; the surface is therefore coarse in texture, rough, and caruncuIated, until weathered, when it presents an unusually smooth and polished appearance with the longitudinal pores particularly noticeable.

Below is a list, with the measurements and characters of each egg in the series which we obtained, with measurements also of the Drayton egg, and of a series of King Penguins' eggs from the Macquarie Islands for comparison.

EMPEROR PENGUINS' EGGS.

No. 1. 13·1 cm. × 8·3 cm. Smooth, bare of chalky covering over the pointed half. Few chalky nodules.

No. 2. 12·0 cm. × 8·2 cm. Very rough, thick, white, chalky covering. Infinite number of nodules. Egg-shell itself pale greenish white.

No. 3. 11·15 cm. × 8·45 cm. Many nodules, forming a ring round the widest part of the egg. Dirty white, chalky covering thick on the blunt end.

No. 4. 11·0 cm. × 7·7 cm. Nodules collected at the sharper end. Chalk covering thin.

No. 5. 12·8 cm. × 7·75 cm. Chalky covering all worn off. Shell surface freely pitted with longitudinal pores a few mm. in length.

No. 6. 12·3 cm. × 8·3 cm. Many nodules. Thick, chalky covering. Seventeen or eighteen longitudinal raised streaks down the length of the shell.

No. 7. 12·15 cm. × 8·25 cm. Dirty greenish chalk all over. Very few nodules.

No. 8. 12·2 cm. × 8·2 cm. Scattered nodules, few. Chalk uniform, but thicker at the sharper end.

No. 9. 10·7 cm. × 8·0 cm. The smallest in the series (Fig. 1, Pl. VI.).

No. 10. 12·8 cm. × 8·6 cm. Thick white chalk all over, and multitudes of nodules, all covered by the chalk.

No. 11. 12·05 cm. × 8·1 cm. Nodules in a ring round middle part of egg. Chalky concretion at each end.

No. 12. 11·0 cm. × 7·5 cm. Many nodules, chiefly round pointed end and middle, in a band.

No. 13. 11·9 cm. × 8·2 cm. No nodules. Chalky covering at both ends.

No. 14. 11·75 cm. × 8·45 cm. Nodules only at sharp end. Chalky covering at both ends. Longitudinal pitting marked.

No. 15. 13·1 cm. × 8·3 cm. The largest in the series (Fig. 1, Pl. VII.).

No. 16. 12·5 cm. × 8·5 cm. Thick chalky covering, and many nodules (Fig. 2, Pl. VI.).

No. 17. 12·5 cm. × 8·5 cm. Marked with slightly raised longitudinal striæ (Fig. 2, Pl. VII.).

Drayton Egg. 10·9 cm. × 7·75 cm. Surface smooth and weatherworn. Longitudinal pitting as in all the weathered eggs. A few small nodules. No remains of chalky covering.

Inscribed: "*Aptenodytes forsteri.* Emperor Penguin. 769."

KING PENGUINS' EGGS.

Greatest measurements in length and breadth of twelve eggs from the Macquarie Islands:—

| | | |
|---|---|---|
| 9·8 × 7·2 cm. | 10·2 × 7·0 cm. | 10·2 × 7·5 cm. |
| 9·9 × 7·5 cm. | 10·3 × 7·5 cm. | 9·9 × 7·3 cm. |
| 10·4 × 7·3 cm. | 10·5 × 7·8 cm. | 10·6 × 7·5 cm. |
| 10·1 × 7·2 cm. | 9·6 × 7·2 cm. | 9·8 × 7·4 cm. |

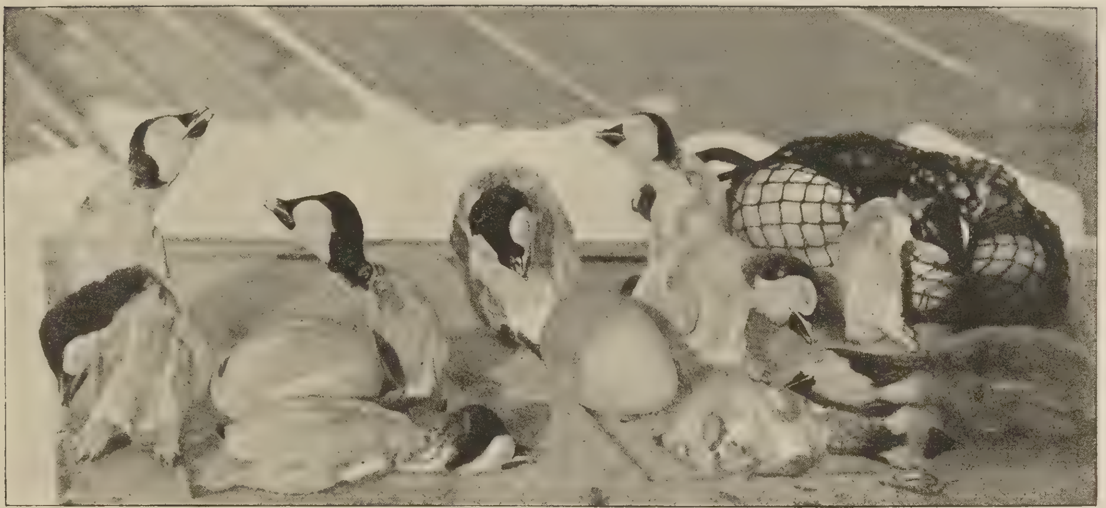


Fig. 23. Frozen Emperor Penguin Chicks and Eggs, picked up at Cape Crozier.

Fig. 24. Eggs of the Emperor, King, and Adélie Penguins.

*To face p. 30.*

The possibility that we have in the Emperor Penguin the nearest approach to a primitive form not only of a penguin, but of a bird, makes the future working out of its embryology a matter of the greatest possible importance. It was a great disappointment to us that although we discovered their breeding ground, and although we were able to bring home a number of deserted eggs and chicks, we were not able to procure a series of early embryos by which alone the points of particular interest can be worked out. To have done this in a proper manner from the spot at which the 'Discovery' wintered in McMurdo Sound would have involved us in endless difficulties, for it would have entailed the risks of sledge travelling in mid-winter with an almost total absence of light. It would at any time require that a party of three at least, with full camp equipment, should traverse about a hundred miles of the Barrier surface in the dark and should, by moonlight, cross over with rope and axe the immense pressure ridges which form a chaos of crevasses at Cape Crozier. These ridges, moreover, which have taken a party as much as two hours of careful work to cross by daylight, must be crossed and re-crossed at every visit to the breeding site in the bay. There is no possibility even by daylight of conveying over them the sledge or camping kit, and in the darkness of mid-winter the impracticability is still more obvious. Cape Crozier is a focus for wind and storm, where every breath is converted, by the configuration of Mounts Erebus and Terror, into a regular drifting blizzard full of snow. It is here, as I have already stated, that on one journey or another we have had to lie patiently in sodden sleeping bags for as many as five and seven days on end, waiting for the weather to change and make it possible for us to leave our tents at all. If, however, these dangers were overcome there would still be the difficulty of making the needful preparations from the eggs. The party would have to be on the scene at any rate early in July. Supposing that no eggs were found upon arrival, it would be well to spend the time in labelling the most likely birds, those for example that have taken up their stations close underneath the ice cliffs. And if this were done it would be easier then to examine them daily by the moonlight, if it and the weather generally were suitable; conditions, I must confess, not always easily obtained at Cape Crozier. But if by good luck things happened to go well, it would by this time be useful to have a shelter built of snow blocks on the sea-ice in which to work with the cooking lamp to prevent the freezing of the egg before the embryo was cut out, and in order that fluid solutions might be handy for the various stages of its preparation; for it must be borne in mind that the temperature all the while may be anything between zero and $-50°$ F. The whole work no doubt would be full of difficulty, but it would not be quite impossible, and it is with a view to helping those to whom the opportunity may occur in future, that this outline has been added of the difficulties that would surely beset their path.

## APTENODYTES PATAGONICA.

### *The King Penguin.*

### (Plate VIII.)

*Aptenodytes patachonica*, J. R. Forster, Comment. Phys. Soc. R. Sci. Göttingensis, iii. p. 137, Pl. ii.* (1781).
*Aptenodytes patagonica*, Miller, Cimelia Physica, Pl. xxiii. (1796); Ogilvie Grant, Cat. B. Brit. Mus. xxvi., 1898, p. 627, *ibique citata.*

LIST OF MATERIAL IN THE 'DISCOVERY' COLLECTION.

No. 132, juv. ♀, Nov. 22, 1901. Macquarie Island. In down. See Birds, Plate VIII., Fig. 1.
No. 133, juv. ♂, Nov. 22, 1901. Macquarie Island. In down.
No. 134, juv. ♂, Nov. 22, 1901. Macqaurie Island. Shedding down.
No. 135, imm. ♀, Nov. 22, 1901. Macquarie Island. Moult of down completed. See Birds, Plate VIII., Fig. 2.
No. 136, ad. ♂, Nov. 22, 1901. Macquarie Island. See Birds, Plate VIII., Fig. 3.
No. 137, ad. ♂, Nov. 22, 1901. Macquarie Island.
No. 138, ad. ♀, Nov. 22, 1901. Macquarie Island.
No. 139, ad. ♂, Nov. 22, 1901. Macquarie Island. Moulting.
No. 140, ad. ♂, Nov. 22, 1901. Macquarie Island. Moulting.

The colouring of the soft parts is as follows :—

*Juv.* Nos. 132, 133, 134.
Upper bill, purplish black entirely.
Lower bill, purplish black with a patch half-an-inch long of pale whitish horn colour on each side, about the middle of its length.
Iris, grey with a brown tint, streaked radially with darker brown.
Eyelids and skin around the eyes of a dusky purplish hue.
Feet and claws, black.

*Immature.* No. 135.
Upper bill, bluish black entirely.
Lower bill, bluish black, shading into a brick-red tinge at the base.
Iris, brown, with darker radial streaks.
Feet and claws, black.

*Adult.* Nos. 136, 137, 138, 139, 140.
Upper bill, bluish black entirely.
Lower bill, bluish black with a conspicuous orange-red plate covering the basal two-thirds on each side of the ramus.
Iris, brown, with darker radial streaks.
Feet and claws, black.
The *pupil* in this bird at all ages is quadrilateral or "diamond-shaped" when contracted, and becomes circular when dilated to its full extent.

NOTE ON THE ILLUSTRATIONS.

Plate VIII. represents the heads of four stages in the growth of this penguin, three of which —Figs. 1, 2, 3—are reproduced from sketches made upon the spot of birds that had just been killed. Fig. 4 is drawn from a remarkable skin in the collection of the British Museum taken in the Snares Islands. As I could not ascertain that such an example had anywhere been previously figured, I asked permission to figure it with those of our own collection. This permission Dr. Ray Lankester kindly gave me. The skin is probably that of a very old and vigorous male bird, and possesses points which are worth more than a passing notice.

* This plate is lettered *Aptenodytes patagonica.*—F. J. B.

For a concise account of the range and distribution of the King Penguin I must refer the reader to Mr. Howard Saunders' account in the "Antarctic Manual." Briefly, it has been recorded from South Georgia, Tierra del Fuego, and the south-eastern portions of the Straits of Magellan, the Falkland Islands, Marion, Kerguelen, and Heard Islands, and the Crozets. Farther East it has been recorded from the Stewart and Snares Islands, New Zealand, and as far south as the Macquarie Islands. It has never been recorded within the Antarctic Circle.

Without attempting to give a complete description of the bird's life history, it will not be out of place if I give a short account of our visit to the Macquarie Island, where, on November 22nd, 1901, we investigated a large rookery of King Penguins at perhaps the busiest time of the year. Macquarie Island lies about 600 miles S.W. of New Zealand, and we made our landing on the east side, anchoring in Fisherman's Cove. The shore is belted by a thick fringe of kelp, and the eastern slopes of the island are covered with a coarse tussock grass, which grows breast high. Between the foot of the hills at this point and the seashore is an extensive beach and a stretch of stony quagmire, with patches of tussock here and there, and it was in this quagmire that the King Penguin rookery was situated (fig. 26, p. 34).

*Megalestris antarctica* was abundant here; we also saw in varying numbers *Larus dominicanus*, *Ossifraga gigantea*, and a Cormorant, one of which was taken and proved to be *Phalacrocorax traversi*; *Sterna frontalis*; *Prion* of more than one species, probably *desolatus* and *vittatus*, and certainly *banksi*; *Diomedea exulans*, a young one; *D. melanophrys*, *Thalassogeron culminatus*, and a species of *Phœbetria*. On shore we found a species of *Ocydromus* in abundance, which has since been named *O. scotti* by Mr. Ogilvie Grant, from a specimen sent home soon after our own visit to the Island, by Lord Ranfurly; and lastly, a large nesting colony of *Catarrhactes schlegeli*, which was quite close to but distinct from that of the King Penguins.

In one of the whalers' huts on shore we found, amongst other things, a collection of prepared bird skins, amongst which I noticed the albino example of *Catarrhactes schlegeli*, which is now in the British Museum collection. This and some other skins I had intended saving from the mice, which had already played havoc with the feet and bills of the majority; but in the necessarily hurried business of transferring a collection of about forty fresh-killed birds and eggs to the boats, they were forgotten. We were surprised on our return to England nearly three years after to recognize the skin in the National collection.

There was in the King Penguins' rookery a large number of birds busily incubating eggs. These, as is now well known, they hold upon their feet, tucked in between the legs and covered from sight by a loose fold of skin and feathers, and so tightly were they held that although we lifted the birds bodily from the ground, yet the egg was very seldom dropped. The object of thus holding the egg is to keep it from the wet and muddy quagmire in which the birds prefer to incubate; a parallel case to the Emperor Penguin, where the object is to keep the egg from contact with the ice.

The Kings' rookery was filthy, neither more nor less, and the whole area smelt abominably. They are large birds, and hundreds are huddled together in close companies, living and breeding on an area of mud, stones, and water at the foot of the overhanging hills. The breeding birds avoid the tussock grass, amongst which one finds only bands of bachelors and unemployed. Generally, the sitting bird makes an effort to keep clean and dry by balancing itself on a stone, a little island as it were, in the muddy trickle that surrounds it. Several birds taken with eggs and marked on the spot as sitters, proved, on examination, to be males, so that probably the parents take turns, one sitting while the other goes to sea to feed.

There were birds in this rookery of all sexes, ages, and conditions, a few adults even in full moult. Many of the young were still in a complete suit of chestnut-coloured down, though almost as big as the adults; many showed different stages of the natal moult, shaggy remnants of the down, commonly as collars only or tufts on the neck, breast, and back, remaining still *in situ*; many showed the clean pale feathers of immaturity, the neck patch being smaller and of a very pale lemon yellow instead of orange gold, the bright red side plate of the mandible being then conspicuous by its absence (fig. 2, Pl. VIII.).

Of the eggs, some were well advanced in incubation, though the great majority were fresh-laid, and the contents of these were excellent eating, without any rank flavour, and with very pale yellow yolks. In no case was there any attempt at nest-making, but each bird balanced on its own little island, resented any interference, either from its neighbours or ourselves. If by chance one of them was overbalanced it fell on its bill and wing tips, and so remained, holding tight to its egg until, by a sudden jerk, it recovered the upright position once again.

The noise in the rookery was so excessive that we had to shout to one another to make ourselves heard above the din. The adults gave out a harsh guttural squawk or a chattering gabble, and the young birds a shrill, piping whistle. If we attempted to drive any of the unemployed into the water, we found ourselves engaged in a very difficult task. When scared, they seemed to have a great repugnance to leaving the shore, as we afterwards found was the case with the Antarctic Adélie Penguins. If we surrounded them and persisted in our efforts, they would dive in and appear beyond the kelp with head, bill, and neck held high in the air, while the body was so low in the water as to be hardly seen at all.

The posture of the bird when "sitting" with an egg has been so often described that it would, perhaps, be superfluous to repeat it here, were it not for the unfortunate way in which the word "pouch" is invariably employed ever since it was first used to describe the incubation methods of this bird. The egg, and this cannot be too plainly stated, is simply held wedged in between the legs, resting upon the upper surface of the feet. Having once been laid, it is never afterwards admitted within the body of the bird that laid it, any more than is the egg of an ordinary barnyard "sitting hen."

FIG. 25. KING PENGUINS ON MACQUARIE ISLAND, SHOWING YOUNG BIRDS SHEDDING THEIR DOWN.

FIG. 26. ROOKERY OF KING PENGUINS ON MACQUARIE ISLAND.

*To face p.* 34.

The food of the King Penguin at this rookery consisted mainly of crustaceans, fish and cephalopods, many cuttle-fish beaks being found accompanied by pebbles in the stomach.

The King Penguin has methods of progression precisely comparable to those which I have more fully described in the Emperor Penguin. It was, therefore, not always easy to catch the bird before it dropped down on its breast and ruined its plumage by tobogganing in the filthy mire ; nor were we ourselves pleasant objects, either to sight or smell, when the chase was over, spattered as we were from head to foot with a most offensive mud.

There are, as I have said above, certain points in the colouration of the King Penguin which are deserving of very careful consideration. Of the colouring of the chicks I will say nothing, since we saw them only in the latest stages; and of the significant differences between these and the Emperors' chicks I have already spoken in dealing with the latter. But in all the older stages I would call attention to a gradual change in the pigmentation of the feathers of the crown of the head, which can be traced from the first year's immature plumage, through the ordinary adult, right on to the extraordinary plumage of such an aged example as that figured on Plate VIII., fig. 4. This bird was taken on the Snares off the coast of New Zealand. Unhappily the sex is not known, but it is probably an old and exceptionally vigorous male.

To begin with, in the first immature plumage, which replaces the down at the end of the first year, the crown is distinct from the rest of the black head as a diamond-shaped patch of pearly bluish-grey. This is seen to be effected, if one examines the crown feathers closely, by the terminal third of each feather being pale bluish-grey tipped with a tinge of yellow, while the central third is black, and the basal third is white. If the same crown feathers are examined from the head of a bird in ordinary adult plumage, the arrangement of the pigment in each feather is found to have completely altered. Instead of three bands there are only two, the terminal half being dark brown or black, with a minute amount of orange pigment intermixed, and the basal half white. Associated with this change in the individual feathers is an obvious change in the crown patch, which instead of being grey is now seen to be black with a greenish gloss, which results from the intermingling of minute dots of vivid orange pigment with the black. The same green gloss is to be seen upon the chin and throat, but at present I concern myself with the crown patch only.

If then we turn to the Snares example, the significance of these minute changes in the distribution of the pigment begins to explain itself. The green gloss on the crown has become definitely circumscribed by rows of feathers with distinctly orange tips, and these I take to be associated with the development of the superciliary golden crests and bands to be found in *Catarrhactes* and *Megadyptes.* If the individual feathers of these primitive superciliary bands are examined more closely, the arrangement of the pigment will once more be found to have completely altered,

for though the basal half is still white, the terminal half is divided equally into black and vivid orange, the orange pigment completely occupying the terminal quarter of the feather.

It is noticeable, too, that in the Emperor Penguin the immature birds show precisely the same pale pearly-grey coronal patch that is found in the immature King, though the changes are not continued in the adult Emperor as they are in the adult King.

In this respect, therefore, namely, the development of golden superciliary feathers, the King Penguin forms a very definite intermediate link between the Emperor and the group *Megadyptes*, while the golden band in *Megadyptes* still further developes into long golden plumes of *Catarrhactes*.

*Pygoscelis*, I am told by Mr. Pycraft, shows certain skeletal characters which are yet more primitive than those of *Aptenodytes*, so that while there appears to be some reason for considering the Emperor Penguin to be a more primitive type than the King, and *Megadyptes* more primitive than any form of *Catarrhactes*, *Pygoscelis* may be considered the most primitive of all. And further, in *Catarrhactes*, judging from the development of the superciliary tract of feathers, *C. pachyrhyncus* and *C. sclateri* are less specialised forms than *C. chrysocome*, while *C. chrysolophus* and *C. schlegeli* are more specialised than any of them, not only on account of the length of their superciliary plumes, but also because the golden bands meet anteriorly in the middle line, of which there is no tendency in the Snares example of *Aptenodytes patagonica*.

It will be seen from the above that this one specimen may be considered to be a key to the whole question, if the head, as I am inclined to think, is in all the penguins the part in which both generic and specific distinctive characters are specially developed, as being the part mainly visible for recognition when these birds are floating on the surface of the water.

## PYGOSCELIS ADELIÆ.

*The Adélie Penguin.*

(Plates IX., X.)

*Catarrhactes adeliæ*, Hombr. and Jacq., Ann. Sci. Nat. (2) p. 320 (1841).

*Pygoscelis adeliæ*, Coues, Proc. Ac. Philad. (1872), p. 196; Sharpe, Rep. 'Southern Cross' Coll., (1902), p. 113, *ibique citata*; Eagle Clarke, Birds of South Orkney Ids., Ibis., Jan., 1906, p. 157, pl. viii.

List of Material in the 'Discovery' Collection.

| | | | | |
|---|---|---|---|---|
| No. 52, ♂, ad. skin. | Nov. 7, 1902. | McMurdo Sound. | Weight, 11 lbs. | |
| No. 53, ♂, ad. skin. | Nov. 7, 1902. | do. | | |
| No. 54, ♀, ad. skin. | Jan. 2, 1903. | do. | See Birds, Pl. IX., fig. 5. | |
| No. 55, ♂, ad. skin. | Nov. 7, 1902. | do. | | |
| No. 56, ♀, ad. skin. | Dec. 22, 1902. | do. | | |
| No. 57, ♂, ad. skin. | Dec. 23, 1902. | do. | | |
| No. 58, imm. skin. | Jan 9, 1903. | Cape Adare—shedding the down. | See Birds, Pl. IX., fig. 3. | |
| No. 59, ♀ imm. skin. | Jan. 27, 1904. | McMurdo Sound—about to moult. | | |

No. 60, ♂, imm. skin. Jan. 19, 1904. Cape Royds—shedding the down.
No. 61, imm. skin. Feb. 12, 1904. McMurdo Sound—See Birds, Pl. IX., fig. 4.
No. 62, ♀, ad. skin. Nov. 9, 1902. Cape Crozier—Isabelline var. See Birds, Pl. IX., fig. 6.
No. 63, ♀, ad. skin. Jan. 22, 1902. do. do.
No. 64, ♂, imm. skin. Jan. 19, 1904. Cape Royds—shedding the down.
No. 65, ♂, imm. skin. Jan. 19, 1904. Cape Royds—shedding the down.
Nos. 170–181, adult skeletons. McMurdo Sound.
Nos. 182–185, juv. in formaline. Jan. 9, 1902. Cape Adare.

*Spirit Specimens.*

No. 235, juv. Jan 9, 1902. Cape Adare.
No. 236, juv. Jan. 9, 1902. do.
No. 237, ♂ juv. Jan. 12, 1904. Cape Royds.
No. 238, ♀, juv. Jan. 12, 1904. do.
No. 239, ♀, juv. Jan. 12, 1904. do.
No. 240, juv. Jan. 11, 1904. do.

Also a collection of eggs taken at Cape Adare, Jan. 9th, 1902; at Cape Royds, Jan., 1904; and at Cape Crozier, Jan., 1902, and Nov., 1902.

The colouring of the soft parts is as follows :—

Bill, when first hatched, blackish. A week old, black terminally, deep red at the gape and along the cutting edges. Immature of the first year, blackish. Adult, brick-red, the upper bill black terminally, and the mandible black along the cutting edge.

Iris, brown, varying between reddish brown and greenish brown.

Eyelids, black throughout the first year; pure white in the adult at 14 months, and onwards.

Feet, flesh red; dusky when first hatched, brightening in the first week or two. Imm. and adult, pale flesh pink above, black beneath (in some cases piebald beneath, see Fig. 6, Pl. X.).

Claws, brown.

List of Material in the 'Morning's' Collection.

| | | |
|---|---|---|
| M 1, ad. sk. | Jan. 19, 1902. | 77° S., 167° E. |
| M 2, ad. sk. | do. | 77° 16′ S., 165° E. |
| M 3, ad. sk. | do. | 77° 16′ S., 167° 55′ E. |
| M 4, ad. sk. | do. | 67° S., 167° E. |
| M 5, ad. sk. | do. | 77° S., 167° E. |
| M 6, ad. sk. | do. | 77° S., 167° E. |
| M 7, ♂, imm. sk. | Nov. 28, 1902. | 68° S., 175° E. |
| M 8, imm. sk. | | Ross Sea. |
| M 35, ♂, ad. sk. | | Ross Sea. |
| M 36, ad. sk. | | Ross Sea. |
| M 38, ad. sk. | | Ross Sea. |
| M 39, ad. sk. | | Ross Sea. |
| M 42, ♂, ad. sk. | | Ross Sea. |
| M 51, ad. sk. | | Ross Sea. |
| M 52, ♀, ad. sk. | | Ross Sea. |

Note on the Illustrations.

Birds—Plate IX. represents the changes in the head from hatching to adolescence. Fig. 1. Just hatched, showing the angular prominence used as egg-scale. Fig. 2. About a fortnight old. Fig. 3. Shedding the down. Fig. 4. Immature bird of third month, in the plumage carried for the first year. Fig. 5. Head of normal adult. Fig. 6. Head of isabelline variety, with occipital crest erected.

Birds—Plate X. represents the changes in the feet of birds of corresponding age to the heads in the last Plate; Fig. 6 alone differs in representing a variation in which the sole was piebald instead of black.

On January 2nd, 1902, we sighted ice for the first time after leaving New Zealand, and for the first time also were surrounded by such typical ice birds as *Thalassœca antarctica* and *Pagodroma nivea.* *Priocella glacialoides* had met us the day before when we were accompanied also by a number of Sooty, Black-browed and Wandering Albatrosses and a few Cape Pigeons. All these left us before the following day. Yet we were in the ice for three whole days before *Pygoscelis adeliæ*, first singly, and then in couples, some immature with white throats, and some adult and black-throated, appeared to greet us with their ringing cry "Aark!" "Aark!"

On this third day we were for the first time amongst the more extensive icefloes, and these being far more closely packed, afforded an excellent opportunity for the inquisitive little birds to run long distances towards us, and with many halts to gaze and cry in wonder to their companions; now walking along the edge of a floe in search of a narrow spot to jump and so avoid the water, now with head down and much hesitation judging the width of the narrow gap, to give a little standing jump across as would a child, and running on the faster to make up for its delay. Again, coming to a wider lead of water necessitating a plunge, our inquisitive visitor would be lost for a moment, to reappear like a jack-in-the-box on a nearer floe, where wagging his tail, he immediately resumed his race towards the ship. Being now but a hundred yards or so from us he pokes his head constantly forward on this side and on that, to try and make out something of the new strange sight, crying aloud to his friends in his amazement, and exhibiting the most amusing indecision between his desire for further investigation and doubt as to the wisdom and propriety of closer contact with so huge a beast; this constantly leads him first to advance and then recede, and eventually to give discretion a permanent advantage over valour (figs. 27, 28, p. 38).

Nothing could exceed the amusing interest which these birds excited in our minds, looking on them as we did for the first time, though the amusement and the interest increased tenfold later on, when we came to watch and study them in the more busy hours of the nesting season at their "rookeries." The number of Adélie Penguins increased day by day as we made our way through the ice pack towards the south. We saw about an equal number of birds in the adult and immature plumages to begin with, but when we reached, on January 8th, the southern edge of the pack, those in the adult plumage vastly preponderated.

The pack ice is a place of safety for the immature birds; here they live and move and find their living in comparative safety for the first two years of their existence, possibly in many cases for the first three years. Here they feel nothing of the ocean swell, which is practically lost under the weight of floating ice within half a mile of the open sea, while they can find shelter from the wind and drift under a friendly hummock. Here they have always a handy retreat upon an icefloe when hunted by the Sea Leopard (*Stenorhinchus leptonyx*), or the Killer whale (*Orca gladiator*). Here, too, they bask and sleep in safety when they have filled themselves to satiety with

Fig. 27. Adélie Penguins.

Fig. 28. Adélie Penguins on the run.

To face p. 38.

the crustaceans which literally swarm amid the icefloes, probably because of the abundance of diatomaceous refuse in the melting and discoloured ice. Here, too, they may confidently trust to a foothold which will last them while they moult their feathers in the autumn, when for a fortnight they are bound to avoid the water, and sit disconsolately fasting in little knots under the lee of one of the larger hummocks.

As we entered open water from the southern limit of the pack, and came in sight of the cliffs of Cape Adare, the numbers of adult Adélies rapidly increased and no more were seen in the plumage of immaturity.

It were well that the zoologist should realise the necessity of seizing every opportunity as it offers, for the entry to the Antarctic through the belt of pack ice may be his one and only chance of making a representative collection of Antarctic animals. He will have much cause for thankfulness at every day's delay in passing through it. Once through, he will as likely as not (and this was our own experience) see little or nothing more of *Lobodon*, *Stenorhinchus*, or *Ommatophoca* amongst the seals, or of mmature Adélies and immature Emperor Penguins, of *Priocella glacialoides*, *Prion*, or *Halobœna* amongst the birds. He may see *Pagodroma*, *Thalassœca*, and *Oceanites* again in numbers, but he may never have so good an opportunity of their close observance, or such a chance of adding them to his collections. The pack ice is the place *par excellence* for close contact with many Antarctic birds and seals, as well as whales and dolphins. Once through the pack, and to my sorrow we were through it in less than seven days, there may be no further opportunity, for on the homeward voyage in February or March no pack ice may be seen, or if seen, it will be in small detached and drifting masses which may be traversed without meeting any sign of life.

The spring pack is the Antarctic hunting-ground, and every hour spent there will bring a rich reward to the naturalist. He may for days together postpone the removal of his clothes, and sleep in snatches when he can, for night and day he will be summoned to the bridge to take notice of some new bird or group of seals. There away on the port bow will be a black object lying on the ice. Is it a Ross' seal, or only another *Lobodon?* If the former, the ship's course may be altered, but if not, then "as you were" until another bunch of six or eight *Lobodon* seals turns up, as happens sometimes twice in the day. The naturalist must decide, and in settling through the glasses whether the seal is a Ross, a Crab-eater, or a gaunt Sea Leopard, he will find exercise for his powers of diagnosis, which will be surely and sufficiently criticised at the next meal below if a mile or two of southing has been lost for the sake of an imaginary Ross. Let him, therefore, who sees a bird, or a change of plumage, whether of moult or immaturity, take it while it offers, the more carefully if he thinks he is sure to have another and a better opportunity later on. In nine cases out of ten the regret will come without the opportunity, and in working out his problems, this or that clue which was one day well within his grasp will almost certainly be missing. With this warning, the result of personal experience, I must proceed to detail more fully the history of the bird now under consideration.

As we neared Cape Adare, we had Adélie Penguins in the water all around us, birds by hundreds dashing in and out like little dolphins, making very rapid travelling through the water, shooting into the air with heads drawn in and wings appressed, just clearing the water by a foot for a yard or more, and then in with the slightest little splash. When first seen, they may easily be mistaken for a school of fish. Under the water they wing their way with powerful strokes, often in a zig-zag course, especially if frightened, as a means, no doubt, of baffling the seals and Killer whales that are their terror. The feet and tail in this method of progression are used for steering only, but if the bird is at the surface, floating as he does low in the water, instead of the wings the feet will be used for propelling.

In landing on a shelving shore, the bird merely swims till he can stand upright and walk, but in landing from deep water on an icefloe with its edge a foot or two above the water, he leaps like a salmon, with this difference, that instead of allowing his body to follow the curve of motion, he preserves the vertical position, and lands upon his feet, immediately running on a few paces or falling sometimes on his breast; and in this landing leap the stiff tail feathers must be of use in preventing any tendency to fall backwards.

Mr. Burn Murdoch has given three feet as a good leap, and I think this is quite likely, though their powers are not often put to such a test. In leaping from floe to floe across a crack of open water, they show no great athletic capabilities, and in crossing six inches or a foot, which is about as much as they ever dare attempt, their movements are exactly what one is wont to see if the same feat is performed by a child of three. If in their wanderings they come to a crack which is too wide to jump, and yet not wide enough for plunging into, they will follow the edge till they find a point more suited to their tastes; but it takes much time and many hesitations before they decide the thing to be possible for either.

Time, happily for them, is no object; but this at first sight one would hardly guess, their movements being always precise, busy, and preoccupied. It is only when one has watched a little party hurrying along for full half a mile in a direct line, as though upon some urgent business, suddenly stop and all go to sleep, or suddenly turn and go off in another direction, or come back upon some equally urgent call, that one begins to realise that their business is not always so important as it looks.

On flat ice or snow they seem to prefer walking (fig. 33, p. 46), balancing themselves with their flippers, and leaving between their footmarks a sinuous track made by the tail. If hurried or fatigued by soft snow they will fall on their breasts, the polished feathers of which form an excellent runner surface for tobogganning. They then leave a track which takes the form of a straight smooth groove with foot and wing marks on each side, each working in alternation with the other.

On land, as, for example, in the rookeries, they progress as far as possible on their feet, and in making the longer journeys up the mountain sides, over very craggy rocks and really difficult steeps, they bring bill and wings into use as well as feet

Fig. 29. Adélie Penguin Rookery at Cape Adare.

Fig. 30. Adélie Penguins' Nursery at Cape Adare.

*To face p.* 40.

and nails, and blood stains in their tracks show that sometimes they must suffer in the process (fig. 34, p. 46).

We saw no marked scratching in the rock surface such as that which has been observed in the Falkland Islands. Probably if one hunted in suitable places in the Antarctic one might find them, for with vesicular volcanic rocks the partitions between the vesicles would easily be broken down by the birds' claws, always in a manner which would assist the subsequent action of water, and the two together would eventually produce deep grooves.

At Cape Adare, however, where some of the birds nest at a height of nearly 1,000 feet, their pathways are peculiar for another reason. They choose, to begin with, the gulleys and "chimneys" which are more or less filled with snow drift, and the constant procession of birds up and down these gulleys in the steep mountain side gradually wears away a number of deep cuttings in the hard snow which intersect one another in every direction, and leave lozenge-shaped pinnacles standing in between. The quaint aspect given to the thoroughfare in this way is seen in the photo reproduced (fig. 31, p. 42).

The pace at which these birds can travel in the water rivals that of many fish; on land they are of course not so fast, though their pace when tobogganing on their stomachs is about as quick as a man can run on ice and snow, and a great deal faster than the birds can travel on their feet.

The question as to whether penguins have in bygone days had the power of flight is still an open one, and I will not attempt to discuss here what is more satisfactorily discussed in another chapter dealing with anatomical details that bear upon the matter of their origin. But, having a strong belief in the permanence of instinctive efforts and habits, even long after their need or their usefulness has disappeared, and having seen a penguin with a strong desire to follow a Skua gull which was flying overhead, crouch down as if to spring and suddenly use its wings as if to rise in flight, while its eyes followed the flight of the Skua, I was so assured of its wish to fly that I could half believe it must once have had the power.

There is moreover the quaint habit in this bird, as well as in the Emperor and the King, and possibly in others too, of sleeping in an upright position with the bill tucked in behind the flipper. This, as I have more fully explained in the case of the Emperor Penguin, is also a habit or posture in which the bird continues to indulge, but which has no *raison d'être* now that the wing is so sparsely feathered. This bird, as is the case with other penguins, sleeps at times on its breast with the head drawn in upon the neck.

Experiments, in themselves cruel, and useless from a scientific point of view, have been made from time to time with a view to settling the number of minutes that a penguin can remain under water and yet live. Undoubtedly the penguin could, if put to it by finding itself under a very extensive sheet of ice, remain and swim under water for a good deal longer than a minute; but in the ordinary

course of events, when feeding or when travelling, it is doubtful whether a longer submersion could be borne with comfort. All that can be seen by watching the bird in the water is that its submersion is of very short duration when travelling rapidly in a straight line. It will leave the water for breath by a leap in the air at intervals which vary from 20 to 50 yards or more; it would be no rare feat to pass under an icefloe of 100 yards, and in doing so the sense of direction is well maintained beneath the ice, as one may see, if the bird is endeavouring to reach a companion some little distance away.

The food of the Adélie Penguin during the summer months consists almost entirely of *Euphausia superba*, a red shrimp-like schizopodous crustacean, which exists in vast numbers in the shallow seas of the Antarctic. These red crustaceans can be seen sometimes in large numbers in the water, frequenting chiefly the ice pack, the edges of the icefloes, or the foot of the ice cliffs which form the sea faces of the Barrier snow plains. Here, therefore—in the early hours of the morning, more abundantly than at any other time, but at every other hour in the twenty-four as well—may be seen hundreds of penguins feeding, their black heads and loud voices proclaiming their business, while they swiftly dash in and out of the water in small companies, like a school of little dolphins.

In its passage through the alimentary track the colouring matter of this crustacean is apparently little altered, so that the ground which is occupied by an Adélie Penguin rookery takes on a brick-red colour from the excrement, and this can be recognised by sight, even at a very considerable distance from the shore. Not only does the general colour of the ground give evidence from afar of the situation of a rookery of Adélie Penguins, but the smell has in more than one case directed us to search for and discover a hitherto unsuspected colony. The smell is unpleasantly fishy and ammoniacal. After a landing from the ship, our clothes and boots, notwithstanding a vigorous cleansing, kept us in constant recollection of the rookery by impregnating our cabins with the smell for days. It is quite unlike the smell of anything else, and to one who has spent a day or two in their midst, though he were blindfold, the smell of the museum skin of a penguin chicken would at once recall the harsh and noisy clamour of some crowded rookery of Adélie Penguins in the south.

On one occasion this smell was forced upon our notice when we were no less than 30 miles from the nearest penguin rookery. Travelling at the time with sledges on the Barrier surface to the south of Mount Erebus and Mount Terror, we were thinking of anything in the world but penguins, when a gentle breeze sprang up across the divide between these two mountains, blowing in a bee-line to us from the great rookery at Cape Crozier, 30 miles away. The smell was faint but unmistakable, and the truth of our perceptions was borne out a little later, when we found some weathered penguins' feathers that had been carried in the same way over the divide, itself a height of from 6,000 to 7,000 feet. We were, moreover, at the time making observations on the quantity of ozone in the air, and in passing into the current which

Fig. 31. Adélie Penguins' Path up the Hills at Cape Adare (*see* p. 41).

Fig. 32. Adélie Penguins' Rookery at Cape Adare. The hut on the right was left there by the 'Southern Cross' Expedition.

*To face p. 42.*

had crossed this extensive track of guano, from the pure air of the barrier plain, the tests which we applied for the 24 hours which included the polluted air, showed a strength of 3 degrees of ozone, compared with a strength of 10 to 12 degrees on other days for half that number of hours.

It may be surmised, therefore, that the sanitary condition of these rookeries is open to considerable criticism, and the place would be unbearable were it not for the fact that the winds are constant, and the temperature of the air in the summer months always, with the exception of one or two days in the year, below the freezing point of water; where dark rock is exposed it will rise a few degrees, but only from contact with the rocks which have absorbed heat from the rays of the sun. The dryness of the air, moreover, is a powerful agent in the prevention of such nuisance as would otherwise arise from so great an abundance of dead bodies and other organic refuse ready to decay, and the remains of a penguin torn to pieces by the skuas will generally dry before it really decomposes.

The quantity of crustaceans brought in during the day to such a rookery as that which exists at Cape Crozier or Cape Adare must be immense, for parents hurry in ashore from one end of the twenty-four hours to the other without cessation, their stomachs loaded with a mess of shrimps (*see* figs. 29, 30, p. 40; also fig. 32, p. 42). Chickens by the hundred stand in little groups of twelve or twenty, now in a state of bulging repletion, now in a ravenous hurry chasing some unfortunate adult but lately arrived with spoil from the open sea.

One may, therefore, infer from the uniform colour of the thin layer of guano in every Adélie Penguin rookery that these red crustaceans do form their staple diet; but at Cape Royds I have known them eat small fish, some three or four inches long, and, no doubt, they also feed on cephalopods, the beaks of which are often found in their stomachs. Beyond the remains of fish, cephalopods, *Euphausiæ*, and other crustaceans, an invariable concomitant in the stomach of this bird is a collection of small pebbles, swallowed no doubt, for the purpose of reducing to a pulpy mass the indigestible parts of the crustaceans. That these pebbles are very necessary may be gathered from their constant presence in the stomach. There is no separate crop or gizzard, as such, in penguins, where the stomach forms one large undivided muscular sac capable of great distension.

The chicken is entirely dependent upon its parents for food from the time it leaves the egg until it has completely shed its down and has assumed a feathering which enables it to enter the water. Undoubtedly it requires a very large supply of food, for its growth is rapid and the state of repletion which eventually brings the chicken to consider that it has had enough is not readily arrived at. One wonders how the young that are hatched out on the summit of such mountainous heights, nearly a thousand feet above the sea, can ever obtain a sufficiency of food. Yet they are as well grown and as healthy there as they are at the sea level, thanks to the untiring efforts of their parents, who form a constant stream passing up and down the sides

of the mountain in beaten tracks. One cannot but marvel at the persistence with which these little birds, using their feet, bills, and flippers, laboriously climb to the summit of such rugged slopes. Why, one wonders, should they ever set themselves such an infinite amount of unnecessary labour when there is ample room for them to nest and rear their young on the flat moraines below ?

The observations made on this rookery at Cape Adare by the zoologists of the Southern Cross' Expedition show that but two journeys could be made to the summit during the twenty-four hours ; and this is no isolated example, for on other rookeries there were nests to be found fully as high and even farther from the shore.

To return now to the actual feeding of the chickens. They have a method which is altogether entertaining, a method which exemplifies in a direct and indisputable manner the far-reaching law of the survival of the fittest. One may stand in the noisy crowd of penguins at Cape Crozier and watch the law in being from its many-sided aspects ; the cruelty, the pathos, the humour, and yet the admirable perfection of the whole system being irresistibly brought home to the observer.

The sooty-grey young ones in the third week of January were almost as big as their parents, and quite as active. Of these young birds there were literally thousands, and all were hungry, many very hungry. Moreover, each individual chicken acted upon the supposition that every old bird as it came up from the shore was full of shrimps. On this assumption the old bird had no choice but to run the gauntlet. Chased incontinently up and down the rookery by the importunate infants, the fond parent ran hither and thither with a keen eye open for the chicken it once had called its own (fig. 38, p. 52). Driven at last to bay, it could only turn to swear and silence its persecuting followers for the moment with a vicious peck, but the moment its search again commenced it would be caught up and followed and worried in precisely the same way by a fresh relay of young ones, all belonging to someone else.

As we stood there and watched this race for food we were gradually possessed with the idea that the chicks looked upon each adult coming up full-bellied from the shore, as not a parent only, but a food supply. The parents were labouring under a totally different idea, and intended either to find their own infants and feed them, or else to assimilate their already partially digested catch themselves. The more robust of the young thus worried an adult until, because of his importunity, he was fed. But with the less robust a much more pathetic ending was the rule. A chick that had fallen behind in this literal race for life, starving and weak, and getting daily weaker because it could not run fast enough to insist on being fed, again and again ran off pursuing with the rest. Again and again it stumbled and fell, persistently whining out its hunger in a shrill and melancholy pipe, till at last the race was given up. Forced thus by sheer exhaustion to stop and rest, it had no chance of getting food. Each hurrying parent with its little following of hungry chicks, intent on one thing only, rushed quickly by, and the starveling dropped behind to gather strength for one more effort. Again it fails, a robuster bird has forced the pace, and again success is

wanting to the runt. Sleepily it stands there with half-shut eyes in a torpor resulting from exhaustion, cold, and hunger, wondering perhaps what all the bustle round it means, a little dirty dishevelled dot, in the race for life a failure, deserted by its parents who have hunted vainly for their own offspring round the nest in which they hatched it, but from which it may by now have wandered half a mile. And so it stands, lost to everything around, till a Skua in its beat drops down beside it, and with a few strong vicious pecks puts an end to the failing life.

Not once or twice, but a thousand times this happens, and the kindness of Nature's seeming cruelty was borne in upon us as we watched its working. All round the rookery are Skuas' nests with their young; the conditions of life are hard, and failures must be many where the standard of efficiency is high. Not fifty *per cent.* of the Skuas themselves survive their infancy; not thirty *per cent.* of the Emperor Penguin chicks survive; and from the corpse-strewn condition of the acres occupied by an Adélie Penguin rookery, where not merely egg shells by the score, but mangled chicken remnants by the many hundred, lie to be trodden into frozen dust, and muddy guano, one may guess, I think, with truth, that even in these communities the death-rate is excessive. No one can walk over a mile or two of such a breeding ground without being astounded by the number of the dead around him. He will notice, moreover, at once that it is not only the youngest of the chickens that die, but that a very large proportion are birds which have already shed their down and have assumed the plumage which enables them to take the water. Why, one wonders, did these birds die on shore? The parents left them, true, but they were ready to be left, and yet apparently they never dared the water, where alone they could escape starvation. Once again the uncompromising character of Nature's teaching was brought home to us as we realized that death was the one alternative to a creature that refused to learn.

Our nearest large rookery of Adélie Penguins was that which was already known at Cape Crozier, a distance of fifty miles by sledge from our winter quarters in McMurdo Sound. This rookery we visited many times, landing there first from the ship on January 22nd, 1902. From the ship also we landed to investigate the rookery at Cape Adare on January 9th, 1902. From the ship again we sighted rookeries on the northern slopes of Coulman Island, on the southern slopes of Cape Jones, on the southern shores of Wood Bay, and on Cape Bird. There was also a small rookery within 20 miles of our winter quarters on the headland now called Cape Royds, and it was here that we encamped for a part of the breeding season in January, 1904. Quite a considerable number of sledge journeys were made to the rookery at Cape Crozier, and at the time of the birds' return in the early spring we were encamped there also for a month. Lieutenants Royds and Skelton visited the rookery more than once to deposit records for the 'Morning,' and the observations brought back by them are incorporated in the present account.

Now, although it will be seen that we were not quite so happily situated for ornithological work as we might have wished, and, although in the case of the Adélie

Penguins we were too far from our nearest rookeries to visit them day by day, or even week by week, yet we were lucky in meeting with the more interesting stages of the bird's development. They begin to arrive at Cape Adare as early as the middle of September, but the more southern rookeries at Cape Crozier were tenanted only by a few dozen stragglers even so late as October 19th in 1903. In 1902, not a bird had arrived even on October 24th. Within a week of these dates, however, they numbered many thousands, the nesting sites had been appropriated, the stones and pebbles with which they make their nests had been freely fought for, and were now by theft being as freely circulated from one end of the rookery to the other.

The penguins' courtship was in full swing, and on every nest squatted the lady while her knight slept standing at her side, or woke to pay her the attention that his chivalry suggested. There are many misunderstandings in these colonies over the misappropriation of property. The nests were all too close to one another, and he had the biggest nest who could most successfully annex his neighbour's pebbles and prevent his own from being stolen. Needless to say, there was hardly a stone of his nest but had been taken from someone else.

The battles royal between the males have been so many times described that little is left for me to say. The females, sitting on their nests, have quarrels with their neighbours, but whereas they followed the time-honoured custom of fighting with their bills, attempting to cut out each the other's tongue, the males fought chiefly with their weight and flippers, and the blows resounded afar as they were hailed down upon the unlucky wight with a torrent of abuse. But plucky they certainly are, for again and again, when overborne and forced to give way a bit on all fours, the beaten individual will be seen to turn and confront his persecutor on his legs again, his eyes aflame, his ruffle up, his chest out, and his flippers working like a windmill.

The voice of the Adélie Penguin has, by every writer on the subject, been given the attention it demands. It is a voice which cannot be ignored, especially when one hears it flowing freely from the throats of many thousands in such a rookery as that at Cape Crozier or Cape Adare. If one walks among the nests, the majority either swear persistently under their breath or shout in a loud harsh voice. The noise is almost unceasing. From a distance it is like a whistling roar, and when, from the cliffs of Cape Adare, we looked down upon the 200 acres swarming with shouting penguins and their whistling, piping chicks, one was reminded of nothing so much as a rink with a thousand chattering skaters; there was the same ringing roar that such a gathering would have in the Crystal Palace.

It is hard to give a description of the individual cries. They begin at one's approach in a low, hoarse, swearing growl, which gets gradually louder and higher in pitch, while the bird bridles up with ruffled crest in front of his swearing spouse. Then, making a wild dash at the intruder's legs, he seizes such garments as he can reach and unmercifully batters his shins with a rain of blows that have been well compared to the rattle of a boy's stick along some corrugated iron palings.

FIG. 33. ADÉLIE PENGUINS, JUST OUT OF THE WATER AND CLEAN IN CONSEQUENCE.

FIG. 34. ADÉLIE PENGUINS IN THEIR ROOKERY, BLOODSTAINED AND DIRTY (*see* p. 41).

*To face p.* 46.

While camping out on Cape Royds, within easy sight and sound of the penguin rookery, we used to think that there was a lull in the almost ceaseless clatter of the rookery about noon or shortly after. Except for this, it was continuous night and day. The birds have a different note of anger amongst themselves—a more disjointed cry—beginning with distinct syllables "ah—ah—ah," rather than a growl. The call note, again, is "Aark," or "Caark," and once heard in the pack ice or at sea is never to be forgotten. It is best imitated by blowing sharply on the edge of a blade of sword grass held between the ball of the thumb and the index fingers, as schoolboys do, or else by sharply drawing the thumb and finger down a resinous piece of string attached to the head of a little cardboard drum. I was suddenly brought back to the Antarctic in the streets of London by hearing a penguin's call note at my elbow one day, as I passed a man on the curbstone selling cork and feather cocks mounted on such a cardboard drum as I describe. The mimicry was exact, though unintentional. I bought the article in question, and a little practice brought it to perfection. The lull which I mentioned as occurring at noon is due to perhaps more birds than usual having gone to sea. Sleep is snatched when and where it is needed, and birds may be found sleeping in the rookery at all times of the day or night, as well as on the icefloe miles away from anywhere.

The voice of the chicken is a whistling pipe, very shrill, very pathetic and very aggravatingly persistent one would think to the adults, who often show their annoyance by scolding their infants roundly. As the nestling grows, the pipe gets louder and more shrill and more persistent until the down is shed, and the bird undertakes its own responsibilities. It then drops the whine and takes on the cry of the adult, a little more shrill and somewhat quavering at first, but gradually merging into the full-voiced cry of the adult.

The first arrivals at a large rookery such as Cape Crozier have naturally the choice of nesting sites, and on the 19th October, 1903, when only a few dozen birds had just arrived, we found them scattered over the rookery at immense distances apart. What advantages the sites chosen had over any others it was hard to see, except that from the highest part of the rookery to the very shore, and as far as it reached from east to west, the one object seemed to be to avoid proximity to any neighbour. Knowing how desperately crowded the place would be within a week, we could not fail to notice this. Sunny ridges had perhaps a preference, but not wholly by any means. There was a company of four or five among the hummocks of ice and stranded bergs on shore, but the rest were exceedingly busy, each one gathering stones into a heap, upon which it shortly sat to form a nest. One or two birds only had paired as yet, the majority were widely separate and intent only on the amassing of private property. Not one of these nests contained an egg, nor indeed was an egg to be found throughout the rookery even ten days later when there were many thousands of birds all mated, and the whole rookery crowded to its utmost limits with well-made nests, each surmounted by a sitting penguin (fig. 35, p. 48).

Ross Sea was then frozen over as far as the eye could reach, and only a very few lanes of water were visible, from which frost smoke was rising here and there, but ten days later the sea was open and every scrap of ice had been blown by recent winds to the Northern horizon, where, as a long glistening line of pack ice, it could be seen shining in the sun. The area of the rookery at Cape Crozier is immense, and runs up the valleys and slopes of Mount Terror from the sea shore to a height of from 700 to 1,000 feet. The main valley in which it lies has a facing almost north, and is for some reason bare of snow. On the eastern limit are two very old and weatherworn blue-ice cliffs, which are remnants of a previous and more extensive glaciation. On the 29th October our visit to the rookery was made in a heavy gale of wind with thick snowdrift from the S.W., but we found that in the rookery valley we were completely sheltered. The prevailing wind there was more nor'westerly than southerly, as we could see by the *sastrugi* or ridges in the snowdrifts.

The nesting sites are arranged with some method, not here and there as the builders fancy, but in groups with neutral ground between them, each group varying in point of numbers from twenty upwards, and relying upon a few of the most pugnacious members for defence. From ten days to a fortnight after their arrival the birds begin to lay, and when each nest contains two eggs the serious incubation begins. Lasting from thirty-one to thirty-four days—three days elapsing between the laying of the eggs, according to Mr. Evans of the 'Southern Cross' Expedition—the business of incubation is shared by the cock as well as by the hen, and at Cape Royds I had the opportunity of seeing the two change places. The hen presumably was sitting on the eggs when the cock came up to her, and she presently stood up. Then began the weird motions that go on in courting times. Standing breast to breast each rubbed its neck against the other's, first one side and then the other alternately, with a gentle cackle all the time (fig. 36, p. 48). The cock was now and again allowed to see the eggs and touch them with his beak and rearrange a stone or two of the nest, and this went on for several minutes, she loath to go, and he, I presume, assuring her the while that she should go and get some shrimps, for there is no fasting during the period of incubation, as some have stated; presently the hen stepped off and the cock at once walked in and commenced to sit upon the eggs. I was surprised in this case that two eggs should remain so long unhatched, and turned the bird off to examine them. One egg had a pinhole in the side, but I had not the heart to disillusion them, and so they went on sitting. Probably the other one was addled.

The climatic conditions which these birds undergo are by no means so severe as those which the Emperor Penguin faces, but they are severe enough in their way. During the winter months from May to August, wandering between S. latitude 61° on the Antarctic Circle, the bird weathers long nights of darkness, much cold and many snowstorms; but probably the conditions here are very much less severe than those given by M. Henryk Arctowski, in his account of the meteorology of the pack in winter, between 70° and 71° S. latitude, some ten degrees farther to the south.

FIG. 35. ADÉLIE PENGUINS NESTING AT CAPE CROZIER (*see* p. 48).

FIG. 36. ADÉLIE PENGUINS CHANGING PLACES ON THE NEST (*see* p. 48).

*To face p.* 48.

Turning to our own observations for the summer months of September to April, when the birds were with us at Cape Royds and Cape Crozier, we found that the lowest monthly mean was − 18·7° F. for September, and that it gradually rose each month, standing at − 8·5° F. for October, + 12·0° F. for November, + °23·1° F. for December, till it reached + 26·1° F. for January, then falling to + 11·2° F. in February, − 0·8° F. in March, and − 16·9° F. in April, when the bird was no more seen with us. The lowest temperature the bird would be subjected to during these months was −41·8° F. in October, 1902, and −43·8° F. in October, 1903. In November the temperature was rarely below zero, and in December and January was from 4° to 9° above. Perhaps the saving grace of the Antarctic climate is the fact that with the lowest temperatures there is rarely any wind. No sooner does a blizzard threaten from the S.W. than the temperature begins to rise, and in twelve hours it may have risen from 40° below zero to nearly 30° above it. With this rise in temperature comes the wind and snowdrift, and while camping in the rookery at Cape Royds in January, 1904, we found no little interest in wandering among the penguins and skuas to see how they faced a blizzard. Much fresh snow was falling, and still more perhaps was drifting. At the onset it was noticeable that the adults which were able to leave their nests did so, and went out to sea in a great hurry. Whether they did this because they found it warmer to be out of the wind and in the water, or because they knew that a gale brought in more food, I cannot say. Such as remained on land looked miserable enough, and they squatted with their backs to the weather, so that the feathers were blown up the wrong way and got filled with drift. The chickens in their down were more comfortable. Forming themselves into big rounded masses by collecting in groups of fifteen to twenty birds, each bird headed for the centre till neither shape nor form was visible. Inside the heap they must indeed have been quite warm; but the outer ones were white with snow.

Up to January 9th, at Cape Royds the chicks were still all in their several nests, being tended and jealously watched, and kept from wandering or being interfered with, by their parents; two chicks were in every nest, but often remarkably different in size, one being twice as big as the other, and probably three days older. Some chicks were almost too big to be nursed, and one might see the quaint figure of a chicken more than half as big as its parent still being "sat on," though nothing but the head and neck could find a covering between the parent's legs. There was noticeable also for the first time on this date, January 9th, a tendency for the chicks to huddle more in heaps together. As yet, however, there has been none of the eager clamouring for food that accompanies the chase of the unhappy parents. The huddling together of the chickens which have wandered from their nests is at this stage much encouraged by the old birds, who station a few reliable guardians in a circle round the *crêche* (*see* fig. 30, p. 42), while the majority give themselves up more persistently than before to the supplying of their offspring's needs. And, while many of the chickens huddle close together for mutual warmth and comfort, a number may be seen

trying to scratch shelters in the soil, an attempt which reminds one strongly of the burrowing tendency of other species of penguins. One may find nests even so late as January 9th, in almost all conditions, some empty and unoccupied, some empty, but appropriated by a busy pair of stone collectors, who the next day desert it, and, of course, leave no eggs. Thirdly, one may find a patient penguin sitting on an addled egg; another may be sitting on a chicken and an addled egg, another on two chickens, one dead as soon as hatched, the other one well grown. And lastly, one with the full complement of two, but markedly unequal in size.

The chickens have now become more and more exacting in their food requirements, and so by a natural sequence each more independent of its own individual parents. In groups in which they mutually support one another from the skuas, they are more protected than would otherwise be the case.

The skuas, however, are always on the watch, and sooner or later a chicken is separated from its group and falls a victim. The following is a case which I take from my diary written at Cape Royds upon the spot. The skua, when I first caught sight of it, was dragging the chick away by the skin of its neck, from the outskirts of a group of penguins to a stream of water. The chick was lively and quite unhurt, about half grown, and piping lustily. From time to time the skua stood off and watched its victim, but at once dragged it back if any attempt was made to reach its companions; these were now about ten yards off. Not a single old bird tried to make a rescue till I had watched for some five minutes. Then a penguin walked up to the skua and drove him off, the chick immediately nestling up to him. This was more than he had bargained for, so at once he left the chick to itself and went about his business.

Again the skua returned and began to drag the chick about by the skin of its neck, pecking it till tufts of down flew from its back and loins. It was soon dazed and bleeding from the head, but although several old penguins passed close by, not one took the slightest further notice or attempted to interfere. For a long time the skua did nothing but peck and pull at its prey, and then stand off to see what result this had, and full fifteen or twenty minutes had elapsed before the chicken was exhausted; the skua then proceeded to tear open the back and make a meal from the parts about the kidneys, which are almost invariably chosen first.

The complete indifference of the older penguins was surprising, for they showed the greatest courage in defending their eggs and chicks from us. I imagine that they have become so accustomed to the ravages of the skuas, that they look upon a chicken separated and once attacked as a chicken lost, and the skua an evil rather to be endured than cured. The skua in this case was obviously afraid of the penguins, it was slim and alert and ready to fly off at a moment's notice, and yet, as a rule, one sees the penguins cower down as a skua flies over them. The margin of safety on each side must be very limited, but it is certainly not conducive to a great belief in the penguin's intelligence when one finds that it allows its only enemy on land to breed

and safely rear its young within a few yards of its own most sacred nest. I have seen the Adélie Penguin peck at and demolish its own egg which had a minute before been removed for inspection and had been put back under it, resenting the intrusion of what it evidently did not recognise as an egg at all. This, again, is no great sign of intelligence.

Of its cleanliness there is nothing to be said but praise, for no bird on earth could possibly be more strictly clean than the Adélie Penguin. Hunt as one might, no parasite could be discovered amid the snowy feathers, nor any trace of dirt or adventitious matter. Within, it has, in common with all other birds and beasts of the Antarctic, abundant nematodes and quite a host of various forms of microbes, but externally it is scrupulously clean.

There cannot now, I think, be much doubt that the Adélie Penguin takes not one year but two to reach maturity. It joins the breeding colony for the first time not at the end of its first but of its second year. Appearing from the egg in the middle of December, the colour of the little downy-coated nestlings is somewhat variable. Two are almost always hatched in each nest, and the interval which elapses between the laying of the two eggs, and so between the hatching of the two chickens, is sufficient to account for the discrepancy in their size. One is generally about twice the size of the other in the earlier stages of their existence. The eggs, varying in size from 6·45 cm. to 7·2 cm. in length, and from 5·0 cm. to 5·5 cm. in breadth (this being the average of ten specimens), are rounded more or less equally at each end, of a white chalky texture without, and are of a green colour within, which by transmitted light is very marked.

In the majority of the chickens the down is uniformly dark and sooty, but here and there in the progeny of quite normal parents one may find nestlings of so pale a grey as to be almost silvery white with blackish heads, possibly a reversion to an earlier type, and, at any rate, suggestive of the young of the Emperor Penguin, which perhaps represents the oldest stock of all.

The changes undergone as the nestling grows are well described by Dr. Bowdler Sharpe in the report on the 'Southern Cross' collections, and, as he there says, the colour of the head is in all cases somewhat blacker in the earlier stages than the remainder of the body. But this difference gradually disappears, owing, no doubt, to the change in the nestling's down, which Mr. Pycraft describes as taking place in this bird before it changes it for the immature first year's plumage. The sooty black, as well as the silver grey, in such as have it, gives way before long to a smoky colour, which gets an old and dusty look by the time it begins to loosen on the under surface of the flippers. This moult begins on the abdomen and the thighs, where the white side stripes appear as the new feathers are disclosed (*see* fig. 37, p. 52); these parts being the first denuded simply because they bear the brunt of the wear and tear. Then it is shed from the face and head, round the bill, and round the tail. The upper breast and neck and back hold longest to the down, which will by now be clogged with ice and dirt and snow, all of which are abundant in the rookery from time to time.

On the 19th of January, 1904, at the Cape Royds rookery in lat. 77° 45′, the moult from the down was in full swing, though not a bird had finished it. For contrast with this, at Cape Adare, some 380 miles further to the north, we saw the same moult in progress on the 9th of January, 1902. This serves to emphasise what has before been noticed, that the more southern rookeries are decidedly later than the northern ones, a fact which one might have expected, because the seasons are relatively far later for a few degrees of southing in those latitudes than in more temperate regions farther north.

The colour of the feet meanwhile has also been undergoing change. When first the chicks are hatched their feet are very dark, and in the youngest nestling we obtained they were a very dusky blackish red. This rapidly alters for a clear bright red, which reaches its maximum in about three weeks, and then gradually turns to pale flesh colour on the dorsal, and black on the plantar surfaces, and these are retained by the bird for life. The soles of the feet are uniformly black as a rule. It is exceptional that such a piebald mixture of flesh pink and black is seen upon the sole as that figured in fig. 6, Plate X. The colour of the nails is blackish to begin with, but they gradually change in a couple of months to brown. The nails of the adult are long, and brown on the upper surface. Underneath they are darker, and there is a surface marking, which is due, apparently, to the wearing of the nail, the deeper parts of which are of a different density to the surface layers. This surface marking is found in the nails of all the penguins, varying much with the habit of the species, some inhabiting hard, some soft ground, and some at times avoiding all wear by a prolonged stay in the water out at sea.

Returning now to the change in colouring which takes place at the finish of the first moult when the nestling down is shed, the first noticeable point is that the throat is white. The general colour of the upper part of the head and neck and back is bluish black, with a sharp demarcation line dividing it from the pure white throat, fore-neck, breast and abdomen. The flippers are bluish black above and white beneath, with blackish patches at the tips, which vary much in size and may be absent. The bill in the adult is brick red with black on the tip and upper surface of the upper mandible, while the lower is black upon the sides along the cutting edge. The eyelids in the nestling are black, and become white only at the second autumnal moult. In the immature plumage the suggestion of white eyelids is given at times by the habit the bird has of showing the white sclerotic above the coloured iris ; in the adult this habit enhances the value of the pure white eyelids which are so characteristic. The white ring round the eye which is seen in every photograph of an Adélie Penguin is therefore not due only to the whiteness of the lids. If the bird is watched when neither frightened nor excited the prominence of this white ring is much reduced and the upper lid is almost hidden under the black feathers of the brow. The colour of the iris varies between a warm or almost reddish brown and a brown which has a decided greenish tinge. In one at least of the younger birds the iris was a definite sage green.

Fig. 37. Adélie Penguin Chickens, at the Commencement of their Moult.

Fig. 38. Adélie Penguin and Young on the Nest.

*To face p. 52.*

It is in this plumage, then, that the young Adélie Penguin is finally left to its own resources at the end of the breeding season. The parents, according to some observers, take considerable trouble in teaching their young to swim, coaxing them to take the water before they migrate to the north themselves, that they may then be independent. By others, however, it is stated that the adults, having watched over their young till they have shed their down and are capable of taking to the water, and so of finding food for themselves, desert them for good and all, and make their own way independently to the north, leaving the young birds to be taught by sheer necessity to find out how to swim and follow after them.

Supporting this latter account is the fact that Mr. Borchgrevink, on his first visit to Cape Adare, found the colony tenanted almost entirely by white-throated young birds of that season's breeding. "The absence of the black-throated penguin at that time is easily explained," he says, "by the fact that the old ones, uncharitable as it may seem, leave their young ones and go to sea towards the time their offspring should be able to look after themselves." And again: "When the old penguins left, the young ones, being able, like the rest of their kind, to live for a long while without food, remained on shore till starvation forced them to work for their own living, and then they, too, went to sea."

A similar course is taken by a number of other birds, as for example by the Little Auk and the Snow Bunting, amongst Arctic birds, while examples from our own country such as the Cuckoo will readily suggest themselves.* Unhappily we were not able to settle this point, as we were never within reach of an Adélie Penguin rookery at the time when this migration was commencing. We were really too far south in the 'Discovery' for the constant observation of any bird except McCormick's Skua, and we were therefore dependent upon the opportunities that could be seized in cruising with the ship or by sledge travelling for observations made at the breeding places of the Antarctic birds.

We were enabled in the course of our visits to the various Adélie Penguin rookeries above mentioned to see the coming of the first few birds in spring, and to see them choose their nesting sites and then to arrive in their thousands. We saw their courtship and nesting, and obtained their eggs, and a series of the young from the first stage to the last in down. It appears, therefore, that when the nestlings' down is shed and the old birds have gone north, the glossy-coated, blue-backed, and white-throated young are thrown upon their own resources with nothing but their instincts for guidance. It was but natural that some of them should go adrift, and instead of going northward where their parents were in safety in the pack, that a few should wander to the south in our direction.

By February 5th we had seen the last of the adults in 1904, and from that date onward we saw none but young birds, the white-throated and immature. But these again were young birds of two very different ages, and the older of the two now

* Little Auk = *Mergulus alle;* Snow Bunting = *Plectrophenax nivalis;* Cuckoo = *Cuculus canorus.*

prove conclusively that the Adélie Penguin takes fourteen months to assume its adult plumage, and two years to reach maturity. The one immature bird that we captured in McMurdo Sound in February was of the glossy blue-backed, white-throated phase, which had but a month ago shed its down. The other was considerably larger, with still a white throat, but a dark brown plumage, which was on the point of being shed, by an autumnal moult, and which during the month of February would be replaced by the full black-throated, blue-black plumage of the adult. Having undergone these changes it would join the nesting colonies in the following spring, and at the commencement of its own third year begin to breed.

This *brown* plumage is merely the weathered condition of the first year's suit, in which some of the blue colour remains, but from which the black has faded by the weathering of a winter and of a summer's sun. The bleaching power of the Antarctic sun is quite extraordinary, and the Adélie Penguin is not the only bird that suffers from it. The adult Adélie is also changed from bluish black to brown before it moults, as also is the Emperor Penguin, both adult and immature. The skua gull's dark brown feathers are often bleached pure white, and the same effect was seen not only in the hair of all the seals, but even in ourselves, for hair and beards were in several cases bleached to a flaxen whiteness at the end of some months of sledging on the Barrier snow plains. That the brown Adélie Penguins taken in February were on the point of moulting was obvious from the fact that just beneath the skin the new set of feathers was imbedded in a mass of fat. The adults were also at this time moulting, and the whole process would be over for young and old well before the onset of the actual winter.

There is nothing to add to what has already been done in describing the adult bird, though of its variations a word or two may be said. In the 'Southern Cross' collections a bird was mentioned by Dr. Sharpe which had a patch of white feathers on the nape. As individual variation in any species was held to be a question of the greatest interest, we kept a constant look-out for examples to illustrate it both in this and every other animal we came across, the interest lying mainly in the fact that the number of species being very limited there is no keen competition and no great difference in the conditions of life or difficulty in obtaining food. And, so far as the Adélie Penguins were concerned, we were struck more by the extraordinary uniformity of their plumage than by the number of even trifling variations.

We procured but one bird irregularly marked, somewhat as in the example mentioned by Dr. Sharpe in the 'Southern Cross' collections, and we saw from the ship at times, when it was impossible to procure the specimens, about two or three other examples of variation in the distribution of black and white about the head and neck. That there should be some such tendency might be expected from the fact that it changes so markedly in the second year; but it is interesting also for the bearing it has on the utility of the markings of just that region of the body.

These examples, though few, are important as far as they go because they

suggest that the tendency to vary lies in the distribution of black and white about the head and neck, which is exactly what one would expect, because it is the recognition area, so to speak, of the various species of penguin—the part which alone is open to view as the bird is floating on the water. The rest of the body would hardly suffice to differentiate a dozen species, and it would be no easy task to differentiate between the birds at sight if the heads were taken off at the shoulders. It is in the head that we have the most marked differences in the build and colour of the beak, wide differences in the colour of the iris, white throats in some and black in others, white bands across the forehead, black bands again across the throat, and a variety of shading and arrangement in the golden superciliary plumes and frontal crests, as though from time immemorial variations in the head had been selected and developed, and the process still goes on.

Hence we get uniformity in those parts which are useless for specific distinction, but are probably of an advantageous invisibility under water; and a tendency to variation chiefly in those parts which carry specific recognition marks. But one may argue that, if the distinctive specific characteristics are to be looked for in the head, there is every reason why the head marks should not vary, and it is certainly hard to see why in any particular part there should be associated at once the necessity for uniformity and a special tendency to variation.

One must allow that whereas in the parts which do not show above water the colouring is governed mainly by the necessity for protective invisibility, yet in the parts that do show above the water there is an inherent tendency to vary, from the very fact that the physiological processes leading to pigmentation have become concentrated in them; a concentration which results from the need for recognition marks in the parts that do come easily into view as the penguin floats on the surface of the water. That the under parts should all be white seems naturally to result from the necessity for invisibility from below, where lurk, not only the fish that the bird must catch, but the seals and whales that would prey upon the bird.

Whatever may be the reason, the fact remains that the demarcation line between the black and white is seen to vary about the head and neck more frequently than elsewhere. And the only other variation noticed in this species was in the case of the foot illustrated in Fig. 6 of Plate X., where the blackening of the sole was irregular, and also in the extent of the black tip to be seen on the under surface of the wing, which varies within wide limits, and which, being common to several species, cannot be considered of much specific value.

There is still one other variation of the Adélie Penguin that must be mentioned. It is the pale or isabelline variety, of which we obtained a specimen in each of two successive years at the Cape Crozier rookery. Both were adults, and in both the parts which should have been black and bluish black were buff or brownish-buff; the feet were pale flesh colour, the nails light brown and the iris also brown.

The head of this bird is figured in Plate IX., Fig. 6, and in comparing it with

Fig. 5, which presents the head of a normal adult bird, it will be seen that in the latter, whereas the feathers of the face and crown are flattened and closely appressed to the head, the feathers of the occiput and neck are raised and form a ruff or collar. It is hardly necessary to say that this ruff is not peculiar to the isabelline bird; it occurs also constantly in those of normal colouration. With the erection of these feathers is associated the wide opening of the eyelids and the exposure of the white sclerotic of the eyeballs, giving the bird an appearance which we are apt to associate with fright. In the Adélie Penguin, however, the appearance is certainly intended rather to induce terror in others, though one may say with truth that any great excitement will cause the erection of this crest, with every sign of rage in voice and attitude. There is no doubt that the Adélie Penguin is a quick-tempered and withal a very plucky bird, though there are sundry points about its character which show a most deplorable lack of the power to draw logical conclusions from even the most suggestive facts. In short, however quaint and attractive may be its personality, one cannot but consider it to be a bird of very small and undeveloped intelligence. For example, it has no enemies to fear save such as live and feed habitually in the water; these are the Sea Leopard and the Killer Whale. Its one and only strong idea of danger in the abstract is therefore connected with the water, and its power of logical deduction is insufficient to grasp the fact that man appearing on the surface of an icefloe and knocking over its companions one by one, can be avoided by leaving the surface of the ice and entering the water. It matters not how many men and dogs may chase it on the icefloe, the more terrified it becomes, the more persistently will it shrink from entering the water. Again, one would have thought that seeing its enemy, the Skua, ravish eggs and young ones daily throughout the nesting season, it would have been a simple logical conclusion to arrive at, that the Skuas were better ousted from the rookeries; but instead we find them constantly in friendly neighbourhood, their nests often within a few yards of a group of penguins' nests and in the very heart of a rookery of penguins. There seems to be in this a deficiency of common sense, since a want of pluck can hardly be considered one of the bird's faults. When confronted by man in the rookery the pair will range up one behind the other as close as can be, with ruffles up and every sign of an anger which soon breaks into assault and battery. Certainly there are a few birds in every rookery easily recognised as cowards at sight, for on approaching them one sees the feathers lie flatter along the head and neck instead of rising into the warlike ruffle, and in a moment they are off as fast as their legs can carry them; but this is not the rule. Hardly a bird but begins to growl and glare with staring eyeballs and ruffling feathers as one approaches his sitting mate, and hardly a bird but will without hesitation attack the most aggressive biped disturber of its peace.

The black-throated Adélie Penguin, although its wanderings are limited strictly to the icy regions, is a regular migrant within those limits. No one else has had quite the opportunity that M. Racovitza of the 'Belgica' had of studying its move-

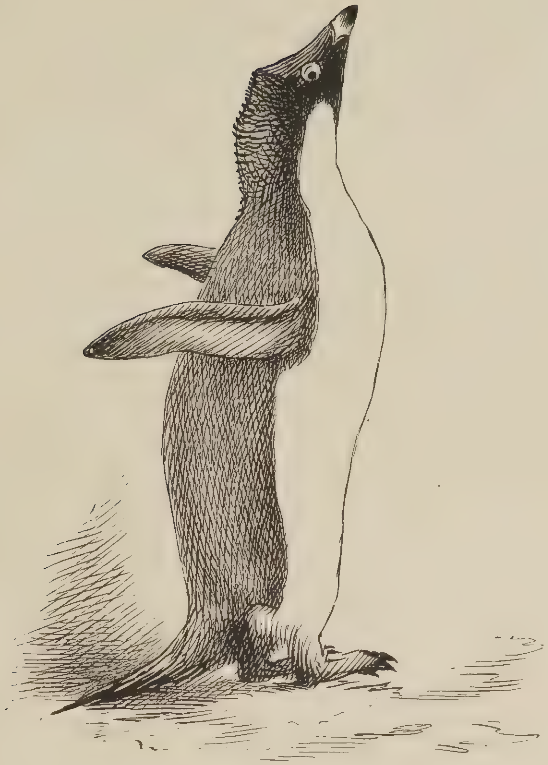


Fig. 39. The ecstatic attitude of the Adélie Penguin.

Fig. 40. Marks made in the snow by McCormick's Skua (*see* p. 67).

*To face p.* 56.

ments during the winter months in the pack. From Dr. Cook's account it is evident that the general exodus from the pack ice to the breeding places in the south, of all or most of the black-throated adults, led him to consider the white throats of the immature birds to be a form of summer plumage. Obviously the sudden relative increase in the number of immature birds in the pack ice when the adults left his neighbourhood, at the commencement of the spring, misled him. His observation, however, was borne out by our own as we made our way through the ice-pack in January. There was a large proportion of white-throated immature birds there which were certainly not breeding. Just a year old at the time, they had yet another year to wait before they would join the southern migration to the nesting colonies. Their home till then was the pack ice and the open sea. There were, also, in the pack ice in January quite a number of adults, which presumably were not taking part in the nesting of that particular season.

From March, therefore, till the latter end of August, the Adélie Penguins, both young and old, are scattered over the northern regions of the ice, where they spend the winter, within easy reach of food and open water. They are also during this time more or less gregarious in habit, though markedly less so than they are in the summer season.

Wherever in the pack ice they can depend upon an open lead of water, at the foot, for example, of an iceberg, penguins may be found in small companies, both young and old, throughout the winter. Not so, however, farther south, where neither sign nor trace of an Adélie can be found from March till the following spring, September or October. What is exactly the farthest point to the south in the Victoria quadrant at which this bird may be found during the winter months, it is at present impossible to say, but one may take their average limits from the beginning of October to the end of February as lying between 61° and 78° 50′ S. Lat., and from the beginning of March to the end of September from 61° S. Lat. to the Antarctic Circle. Individual birds have been known to wander, apparently lost, on the Great Ice Barrier some 60 or 70 miles from open water, but this was certainly accidental. The general migration southward from the pack ice applies to the adults only, and occurs about the middle of October. The general migration to the pack ice north again takes place in two sections, that of the adults about the third week in January and that of the season's young a week or two later. Such adults as we found at the nesting rookeries after this were always in full moult, and one must believe that their moult had inconveniently overtaken them before they started north, and so enforced their waiting till its completion. Amongst the more southern individuals the moult begins in the latter end of February; on Feb. 17th in 1904, when we landed at Cape Adare, we found a very large number of adults, all moulting; there was then not a single immature bird with them. They had but one choice, either to leave the safety of the land on an icefloe, which might break up and precipitate them into the water, or to remain safely where they were on land and wait for a fortnight till their moult was completed, and then go

north by sea or ice as opportunity offered. One thing they would on no account risk, namely, to enter the water during the moult, and so they took the latter alternative and waited, fasting, where they were.

The feathers that were being shed were old, worn, and faded, giving the bird a brownish look all over. They were shed, moreover, not feather by feather, but in spurious sheets, large numbers of them being held together, as Mr. Pycraft has pointed out to me, by the cohesion of the barbs and barbules. The size of the bird as the old coat loosens is prodigious compared with the sleek and slim appearance of the newly moulted one, for not only do the old feathers stand out at right angles to the skin, but the thick layer of fat in which the new feathers are embedded is still below the skin. As the new feathers develop, this layer of fat diminishes, and the difference in the close fit of the glossy blue-black plumage and the old dishevelled loose brown coat is more than ever marked.

There are, therefore, to recapitulate the various plumages and moults.

1. Downy plumage carried for one month from Dec. 15th to Jan. 9th, and in this, I understand from Mr. Pycraft, there are two distinct phases. In the light of this observation the variation of the first phase, which I have noticed above (see page 51), in the colour of the youngest chicks is the more interesting. The silvery aspect lasts only for the first week or less, and during this stage the silvery-white character of the down and the black head strongly suggest the colouring of the Emperor Penguin's young. One is inclined to think in consequence that the colouring of the Emperor's chick is on the whole more primitive than that of the King Penguin's chick. This transitory silver grey phase in *Pygoscelis adeliæ* no doubt corresponds to the white phase of the chick in the *Pygoscelis antarctica*, as described by Mr. Eagle Clarke, and the second smoky phase of *P. adeliæ* with the second phase of the chick of *P. antarctica.*

The nestling's down is moulted between Jan. 9th and 16th, and the ensuing juvenile white-throated plumage is carried for thirteen months from Jan. 16th to Feb. 15th of the following year.

The next moult, to the black-throated adult plumage, follows between Feb. 15th and March 7th.

It is possible that a year more is spent in the pack-ice after the adult plumage has been acquired, and that these are the black-throated birds which are seen in such numbers in the pack-ice in January, many hundreds of miles away from the business of the nesting colonies. If this be so it would postpone the commencement of breeding till the end of the bird's third year, and this is quite possibly the case. One thing is certain, that having assumed the livery of the adult, which is identical for male and female by the month of February, they wear it without much deterioration throughout the winter in the pack. The moult in all stages of immaturity is autumnal, and being also an autumnal moult in the adult, it may be called post-nuptial.

## CATARRHACTES SCHLEGELI.

*The Royal Penguin.*

(Plate XI., Figs. 1 and 2.)

*Eudyptes schlegeli*, Finsch, Trans. N. Zeal. Inst. VIII. (1876), p. 204.
*Catarrhactes schlegeli*, Ogilvie Grant, Cat. B. Brit. Mus. XXVI. (1898), p. 643, *ibique citata*.

### List of Material in the 'Discovery's' Collection.

No. 141, imm. sk., ♀. Nov. 22, 1901. Macquarie Island. Short superciliary crest feathers. Grey chin.

No. 142, imm. sk., ♂. Nov. 22, 1901. Macquarie Island. Short superciliary crest feathers. Grey chin.

No. 143, ad. sk., ♂. Nov. 22, 1901. Macquarie Island. Long superciliary crest feathers. Chin white, throat grey

No. 144, ad. sk., ♂. Nov. 22, 1901. Macquarie Island. Long superciliary crest feathers. Chin and throat white, except for a small spot of grey on the latter.

No. 145, ad. sk., ♂. Nov. 22, 1901. Macquarie Island. Long superciliary crest feathers. Chin and throat white. This male was taken from the nest where it was incubating an egg.

Also twenty eggs of *Catarrhactes schlegeli*, and the materials of one of the nests.

The colouring of the soft parts :—

*Adult* :—

Iris, bright red.
Bill, upper and lower, bright orange pink, the upper slightly more crimson in tone.
Naked skin at the gape, vivid crimson, shading to purple anteriorly.
Feet, pale flesh pink.
Claws, pale brownish horn colour.

*Immature* :—

Iris, bright red.
Bill, dusky orange pink.
Naked skin at the gape, dusky red.
Feet and claws as in the adult.

### Note on the Illustrations.

Birds, Plate XI., Fig. 1 represents the head of an immature Schlegel's penguin, probably at eleven months ; the colouring, both in this figure and in Fig. 2, which represents the head of an adult ♂, is taken from freshly-killed birds. The main difference in the colour of the soft parts is in the degree of brilliance, particularly in the colour of the naked skin about the angle of the mouth. Fig. 3 represents the head of *Eudyptes antipodum*.

*Catarrhactes schlegeli*, commonly known as the Royal Penguin, has been recorded from New Zealand, Campbell Island, and the Macquarie Islands. It is a localised species and breeds only at the last place.

The rookery that we examined on the occasion of the 'Discovery's' visit to these islands on November 22nd, 1901, was situated on a shelving beach in Fisherman's Cove, on the eastern side of the island, not far removed from the water's edge. It was

in a very much drier spot than that chosen by the neighbouring King Penguins, and considerably more limited in size and extent. Definite nests had been made by each pair of birds quite close to one another, composed of grey pebbles, twenty to thirty in number, small and large, with water-worn bones picked up on the adjacent shore. They were well-formed structures with raised edges, circular, and with a good depression in the centre of each. The birds had already made good progress with their incubation, for in every nest we found an egg, and they were all too fully incubated to be useful as food. The male shares the labour of incubation with the female, and the process is said to be completed in a month. The eggs we took were about three parts incubated.

Their measurements vary between 7·5 cm. and 8·5 cm. for the longer diameter, and between 5·5 and 6·25 cm. for the shorter diameter; thus in five of the eggs taken the measurements are as follows:—

| | | |
|---|---|---|
| 8·2 cm. × 6·1 cm. | 7·8 cm. × 5·5 cm. | 8·0 c.m × 5·9 cm. |
| 7·5 cm. × 5·9 cm. | 8·5 cm. × 6·25 cm. | |

They are all pyriform in shape, and have the usual chalky-white shell which characterises the eggs of other penguins.

A most interesting article, by Mr. Bickerton, dealing with the Royal and King Penguins' rookeries on this island is to be found in the "Pall Mall Magazine" for November, 1897. In it he gives September as the month in which this bird begins to lay. This does not quite agree with our observations, from which we concluded that the eggs could not have been laid before the middle of October. Mr. Bickerton's visit was made in March, 1895, and it is possible that he was misled by the account of the sealers who accompanied him. He says, further, that the Royal Penguins begin to arrive at the Macquarie Islands in January to moult, and upon his arrival in March, although birds were still arriving, yet the moult was still in progress. It is said to last three weeks, and during this time, as with other species of penguin, the birds live on their very plentiful supply of fat, since they will not enter the water until the process of moulting is completed.

The young are said to be ready for the water within three months of hatching. If this is so the down must be shedding about the month of February, and Mr. Bickerton arrived only just too late to see them. The whole process of incubation and chicken rearing by the Royal Penguin is, therefore, very comparable to that of the Adélie Penguin farther south, but every stage takes place about a month earlier.

When we were on the spot in November no moulting birds were to be seen, and every bird was paired, nests made, and an egg laid to each pair of birds. Their condition was so uniform throughout that we could only conclude that the laying of eggs takes place, as in the Adélie Penguin, almost to the day throughout the rookery, and not over a considerable extent of time, as in the case of the King Penguin. Only two phases of plumage were to be seen in November. First, and by far the most numerous, were the fully adult birds with white throats and chins, and long

golden-yellow superciliary plumes. Secondly, there were a considerable number of yearling birds, with dark grey chins and throats and short golden plumes. Besides these were to be found a certain number with slight traces of grey persisting upon the throat, birds which, judging from the length of their plumes, were at least two years old, if the grey-throated birds were correctly considered yearlings.

Fig. 1 of Plate XI. gives the features of the head of the yearlings, Fig. 2 the head of an adult male. It is interesting to note that the lemon-yellow tinge, which is seen on the white feathers at the base of the mandible in Fig. 2, has its exact counterpart in the same position in *Megadyptes antipodum*, which has been figured on the same plate for the sake of comparison (Fig. 3, Plate XI.).

Further, it is significant to note that this is the region in which the King Penguin developes the same greenish gloss that is to be seen upon the crown and superciliary regions. This greenish gloss on the crown I have shown (*see* pp. 35 and 36), in the case of the King Penguin, to be the earliest indication of the orange-yellow pigmentation, which eventually colours the superciliary crowns and crests of *Megadyptes* and *Catarrhactes*. That it should be apparent not only on the crown of the King Penguin, but also on its chin and upper throat, is obviously an indication of a tendency to produce the yellow pigment there, and consequently it is to be found quite conspicuously developed in *Megadyptes*, and to some extent also in *Catarrhactes schlegeli*, suggesting that the affinities between *Aptenodytes* and the two genera just named are more close than might otherwise have been expected.

For we have, thus, not only in the crown and superciliary region, but also in the throat, a development of a very characteristic pigmentation from *Aptenodytes forsteri* through *A. patagonica* to *Megadyptes*, and so to *Catarrhactes schlegeli*. There appears to be no similar tendency in the other members of *Catarrhactes*, and certainly in *Pygoscelis* one would not expect it, as it is only just making its appearance in *Aptenodytes*.

The fully developed plumes of *Catarrhactes schlegeli* present a very grotesque appearance as they stand out on both sides of the head and frame the fierce-looking blood-red eyes and the large red bill. The birds looked like harpies cowering over their nests on our approach, swearing and growling in concert with the harsh and angry cries of their neighbours in a way which was almost deafening.

While engaged in incubating its egg the bird squats in the same manner as the Adélie Penguin, right down upon its breast. There is no effort to hold the egg between the legs, and in no case was the egg lifted when we raised the bird from its nest. Yet the production of a single egg may be considered the first step towards what one may call the hyperpodial method of incubation employed by the King and Emperor Penguins, which although more primitive than *Catarrhactes* in some respects, must be considered more highly specialised in this particular direction.

I have elsewhere mentioned that we found the skin of an albino Royal Penguin in one of the huts on shore, with a large collection of other bird skins prepared and

left there. This albino was entirely white except for the golden superciliary plumes, which were well developed. It now forms part of the British Museum collection.

To recapitulate the life history of this penguin, it appears that in January the birds begin to arrive at the island, and continue to arrive till the end of March. The moult of the adults is in progress throughout February and March, each bird spending the three weeks necessary for the process on shore, fasting. From March to September presumably the birds remain at sea. In September they come again to land in numbers and prepare to nest. In September or October a single egg is laid in each nest, and the young are hatched out at the end of November. These remain on shore from December to the end of February, when, having shed their downy plumage, they take to the water and leave the coast clear for the moulting adults.

## MEGADYPTES ANTIPODUM.

*The Great Penguin.*

(Plate XI., Fig. 3.)

*Catarrhactes antipodes*, Hombr. et Jacq., Ann. Sci. Nat. (2), xvi. (1841), p. 320.

*Megadyptes antipodum*, Ogilvie Grant, Cat. B. Brit. Mus., xxvi. (1898), p. 644 ; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 138, *ibique citata.*

### Material in the 'Discovery's' Collection.

(*a*), ad. sk. March 24, 1901. Laurie Harbour. Auckland Islands.

Colouring of the soft parts (see Birds, Plate XI., Fig. 3) :—

Upper bill, brick red, almost throughout ; some small amount of white showing at the junction of the plates.

Lower bill, terminal quarter, brick red ; the rest pure white, except for a narrow broken line of brick red dots which run along and close to the cutting edge on each side.

Iris, bright yellow.

Eyelids, pink.

Legs and feet, flesh pink dorsally except the toe tips, which are black dorsally all round the claws. The sole of the feet wholly black.

Claws, dark brown.

We had but little opportunity of studying this bird, but two were caught in Laurie Harbour, just moulted, on March 24th by Dr. Souter, the surgeon on board the second relief ship 'Terra Nova.' The head of one of these in its new plumage, not yet quite completely developed, is figured (Plate XI., Fig. 3). As we passed the east coast, we saw in the distance, on Ewing Island, a scattered rookery of penguins on the low rocky shore, but we were too far away to be certain of the species even with glasses. The bird, however, is known to breed there, but it breeds always in small companies, and does not form large rookeries as do the other Penguins. The specimen obtained is interesting chiefly on account of the stage of moult which it exemplifies. As exhibiting a definite stage between *Aptenodytes* and *Catarrhactes* it has been mentioned above (see p. 61) in connection with the development of yellow or orange pigment in the feathers of the superciliary region and the chin.

## STERNA *sp. inc.*

On March 1st, 1904 (67° 30′ S., 170° E.), while passing through some very loose pack ice on our way to the north we saw two or three whisps of Tern. It was the only occasion on which we encountered the bird. The day was misty and the birds were all apparently making their way to the north or north-west, evidently in an autumn migration. The crown of the head, forehead and nape were black, the tail and rump were white. There was a white border to the wing and the rest of the upper parts were grey. The bill was black or very dark. They flew in companies of from three to six birds together and alighted frequently on the icefloes, giving a clear whistling note while on the wing. We saw neither this nor any other Tern farther south, nor were we able to procure a specimen on this occasion. It is possible that the birds we saw were examples of *Sterna vittata*, but I am more inclined to think they were *S. hirundinacea* from the extent of white upon the rump, and the distinct white border to the wings. The bird has also been recorded from the South Shetlands and South Orkneys (Sharpe, "Rep. 'Southern Cross' Coll.," p. 165, 1902; Eagle Clarke, *op. cit.*).

## MEGALESTRIS ANTARCTICA.

*The Antarctic Skua.*

*Lestris antarctica*, Lesson, "Traité d'Orn." (1831), p. 616.
*Megalestris antarctica*, Gould, P.Z.S., 1859, p. 98; Sharpe, "Rep. 'Southern Cross' Coll.," (1902), p. 172, *ibique citata*; Eagle Clarke, Birds of South Orkney Ids., Ibis, Jan., 1906, p. 180.

Material in the 'Discovery's' Collection.

No. 147, ad. skin, ♂. Nov. 22, 1901. Macquarie Island.
No. 148, ad. skin, ♂. " " " "
No. 149, ad. skin, ♂. " " " "
No. 150, ad. skin, ♀. " " " "
No. 151, ad. skin, ♀. " " " "
No. 152, ad. skin, ♀. " " " "

Colouring of the soft parts:—
Bill, wholly black.
Iris, very dark brown.
Legs, toes, webs and claws, black.

Also a collection of eggs taken on Nov. 22, 1901. Macquarie Island.

Occasionally, as in a specimen seen in the Auckland Islands in March, 1904, the legs of this Skua are piebald, black and white, as I have mentioned is so often the case in *Megalestris maccormicki* (see p. 68).

There is no possibility of confusing this Skua with the more southern form, *Megalestris maccormicki*, which is confined to the ice. *M. antarctica* is very considerably larger, and darker, although there is a tendency to variation as in *M. maccormicki* within certain limits.

We obtained six examples of *Megalestris antarctica* from the Macquarie Islands, but unfortunately none from the Aucklands, where the birds appeared to be even darker and larger than they were in the Macquarie Islands. We found it nesting in the latter islands on November 22, 1901. Each nest contained two eggs laid merely on the ground, with rarely a few bents lining a shallow depression. The birds not only threatened to attack those who interfered with them, but also occasionally attempted to draw them away by feigning an inability to fly. They live here as skuas do elsewhere, largely by harassing other birds till they disgorge. We saw one dipping at a Whale-bird (*Prion*). Fear was a thing apparently unknown to them, for in the open ocean we watched them chasing even the largest albatrosses, and no sooner did the sailing flight of the Skua change for its bee-line stoop than the albatross would immediately drop to the water, there to remain until either its tormentor was gone, or the coveted food in its stomach had passed beyond recall.

On the Macquarie Islands the Skuas patrolled the penguins' rookeries with great persistence, and no doubt took a fair share of the eggs and young. The most northerly point in open ocean at which we observed *Megalestris antarctica* was 37° 33′ S., 6° 9′ E. on Sept. 29, 1901, in the South Atlantic ocean. The most southerly point at which we saw the bird was 56° S., 176° E. on March 11, 1904, and we were then immensely struck by the obvious difference between it and Maccormick's Skua to which we had grown so accustomed during the preceding two years. Instead of the smaller, pale or parti-coloured bird, we saw a much larger, darker, and stronger bird of one uniform brown all over, chasing albatrosses. Undoubtedly it was most distinct, for we had seen nothing like it amongst thousands of Maccormick's species farther south, and the distinction appears to be well confirmed by a comparison of their young.

## MEGALESTRIS MACCORMICKI.

*McCormick's Skua.*

(Plates XII., XIII.)

*Stercorarius maccormicki*, Saunders, Bull. B.O.C. III. (1893), p. 12.
*Megalestris maccormicki*, Saunders, Cat. B. Brit. Mus. XXV. (1896), p. 321, pl. I.; Sharpe, Rep. 'South. Cross' (1902), p. 166, *ibique citata;* Eagle Clarke, Birds of S. Orkney Ids., Ibis, Jan. 1906, p. 182.

List of Material in the 'Discovery's' Collection.

| | | | | |
|---|---|---|---|---|
| No. 66, | ♀, ad. sk. | Jan. 31, 1902. | Great Ice Barrier. | |
| „ 67, | ♂, ad. sk. | Jan. 31, 1902. | „ | |
| „ 68, | ♂, ad. sk. | Feb. 24, 1904. | Cape Adare. | Weathered and white. (Fig. 5, Pl. XII.). |
| „ 69, | ♀, ad. sk. | Feb. 24, 1904. | „ | |
| „ 70, | ♂, ad. sk. | Jan. 31, 1902. | Great Ice Barrier. | Young bird. (Fig. 4, Pl. XII.). |
| „ 71, | ♂, ad. sk. | Feb. 2, 1903. | McMurdo Sound. | |
| „ 72, | ♂, Imm. sk. | Feb. 24, 1904. | Cape Adare. | Just able to fly. (Fig. 3, Pl. XII.). |
| „ 73, | ♀, ad. sk. | Mar., 1903. | McMurdo Sound. | |

| | | | | |
|---|---|---|---|---|
| No. 74, ♂, ad. sk. | Mar. 15, 1903. | McMurdo Sound. | | |
| „ 75, ♂, ad. sk. | Nov. 27, 1902. | „ | „ | |
| „ 76, ♂, ad. sk. | Mar., 1903. | „ | „ | |
| „ 77, ♀, ad. sk. | Feb. 24, 1904. | Cape Adare. | | |
| „ 78, ♀, ad. sk. | Jan. 31, 1902. | „ | | Weathered and white. |
| „ 79, ♂, ad. sk. | Jan. 20, 1903. | McMurdo Sound. | | |
| „ 80, ♂, ad. sk. | Jan. 15, 1903. | „ | „ | |
| „ 81, ♀, ad. sk. | Dec., 1902. | „ | „ | |
| „ 82, ♂, ad. sk. | Jan. 15, 1903. | „ | „ | |
| „ 83, ♂, ad. sk. | Nov. 27, 1902. | „ | „ | |
| „ 84, ♀, ad. sk. | Dec., 1902. | „ | „ | |
| „ 85, ♀, ad. sk. | Dec., 1902. | „ | „ | |
| „ 86, ♂, ad. sk. | Dec., 1902. | „ | „ | |
| „ 87, ♀, ad. sk. | Nov. 27, 1902. | „ | „ | |
| „ 88, ♀, ad. sk. | Feb. 8, 1903. | „ | „ | |
| „ 89, ♂, ad. sk. | Dec., 1902. | „ | „ | |

Nos. 167–169, ad. skeletons. McMurdo Sound.
„ 225–229. Young Nestlings in Spirit. Cape Royds.
„ 230–234. Young Nestlings in Spirit. Cape Adare.

Many eggs of this bird were taken, and preserved in "clutches," and singly, from Cape Adare, Cape Royds, Cape Crozier, etc., at various dates during November, December, and January.

The colouring of the soft parts is as follows :—

Bill of the nestling, bluish grey, gradually darkening to black as the bird attains to maturity. Bill of the small adult, black.

Iris, dark brown at all ages.

Legs, toes, and webs, pale bluish grey in the young when just hatched, gradually blackening from the extremities upwards, until, when the bird is full-fledged, the feet and legs are black except for a patch of bright blue just above the tibio-metatarsal joint. In the adult, wholly black.

Claws, black at all ages.

### Note on the Illustrations.

Plate XII. represents the head of *Megalestris maccormicki* in five stages of growth.

Fig. 1.—The nestling, when first hatched, with the egg scale still attached to the upper bill.

Fig. 2.—The nestling at about two weeks, showing the rapid growth of the bill, and the change in its colour.

Fig. 3.—The fledgling at about seven weeks, when the bird is just beginning to attempt the use of its wings. The down in this case (Skin, No. 72) is completely shed, and the plumage is soft and close, of a uniform grey, very different to what it would be in another week or two when the feathers have assumed the harder character of the adult, and are dark brown in colour.

Fig. 4.—Represents the head of a young adult in the first year, with but little attempt at the display of a yellow collar.

Fig. 5.—Represents an adult bird with the bleached and whitened plumage, which characterises the bird at the end of the summer months, before the moult.

Plate XIII. represents the feet of McCormick's Skua in various stages of growth.

Fig. 1.—Of the nestling immediately after leaving the egg.

Fig. 2.—Shows the encroaching blackness which gradually creeps up the foot and leg from the terminal border of the webs and claws. This is the foot of a bird at two or three weeks.

Fig. 3.—A stage of colouring reached at the shedding of the downy plumage.

Fig. 4.—The foot of a normal adult.

Fig. 5.—The pied foot and leg of an abnormal adult. See p. 68 for reference to this figure.

In the South Victoria Land quadrant of the Antarctic area the occurrence of McCormick's Skua (*Megalestris maccormicki*) is limited to the ice (*see* fig. 41, p. 68). Nor does it in any other part of the Antarctic seem to wander into more temperate regions, its place being taken in the sub-Antarctic area by the more robust form *Megalestris antarctica.* Having accustomed ourselves to the appearance of the latter, which was with us day by day on our outward voyage for months, we had no difficulty in at once recognising the smaller and paler form of the ice pack as a distinct species. From January 5th, when we met with it, onwards throughout the summer months we had it always with us. Hardly a day passed in the summer but McCormick's Skua was noted, though not always in excessive numbers, except when we neared an Adélie penguin rookery. Then the Skua would always become abundant, and the bloody remnants of penguin chickens would be sufficient testimony to the nature of its needs.

In the "Antarctic Manual" Mr. Howard Saunders gives 78° S. lat. for the southernmost occurrence of McCormick's Skua, and about 70° S. lat. as its limit to the north. These must now be extended, and in doing so this gull must be given the distinction of having been farther south than any other known bird. We met it first in January, in the ice pack of 68° S. lat., but on our return north two years later we saw it for the last time at the Balleny Islands on March 1st, when we were in lat. 67° 20″ S. And for its southern range we saw two or three examples so far south as 80° 20′ S. An explanation of this occurrence will be found below, though it is right to say at once that in a sense we drew them to us from about 78° S. lat.

The variety of colouring in this skua was very noticeable at Cape Adare, where we landed for a few hours on January 9th. The colour of the head and neck and breast varies from a very light buff, or almost white, to a dark rich brown. Everywhere on the higher slopes the bird was nesting, and young of all stages as well as incubated eggs were taken on that day.

On January 15th we entered an ice-bound inlet, Lady Newnes Bay, and again met with McCormick's Skua, in attendence this time on a colony of Weddell's Seals and a company of moulting Emperor Penguins. The Skuas were not nesting here, for we were surrounded by ice cliffs and snow-covered rolling slopes. They were more than ever tame and fearless, and could be approached to within a yard or two as they fed on the blubber of the seals we had killed for food.

Adrift here for ten hours with three companions on an ice-floe, I had time to watch some of the birds that kept us company during the hours of the night. The Skua we noticed sleeping as it squatted on the ice-floes, from 2 a.m. till 7 in the morning, and a trait in the bird which we found to be very characteristic was the habit of settling, the one just ahead of its mate, both with outstretched wings and head well up, vociferating with loud and rapidly repeated cries before closing up the wings. Their habits are in every way like those of other Skuas, and having no other gulls to attack, as have their northern relatives, they content themselves by

attacking one another or the smaller petrels on the wing till the weaker disgorges what he has eaten.

Again, in Granite Harbour, on the west coast of McMurdo Sound, we found them nesting, with young and even eggs, though it was so late as January 20th. We then crossed over to Cape Crozier, where many Skuas nest, and practically live on the Adélie penguins of the enormous rookery there, and here we saw the bird settle deliberately on a healthy penguin chick and peck its eyes out.

On January 31st we were at the extreme eastern end of the Great Ice Barrier of Ross, and off the new land, now called King Edward VII.'s Land, we procured three Skuas, which on the same day provided us with examples of the two extremes of colour variation and an intermediate form. One bird was uniformly dark all over, another was weathered and bleached, with an almost white head and breast and white splashes on the back and mantle, while the third was a stage between the two. This variability has nothing whatever to do with sex, but much to do with age and moult. The moult which replaces the bleached and whitened feathers is apparently more complete and rapid in the young than it is in the older birds.

Returning along the Barrier we saw that the Skuas were almost as constant in their attendance on the seals as they were upon the penguins. So late as February 9th they still had nestlings in down, and on this day we reached our winter quarters in McMurdo Sound. We then had bad weather for some days, and on the 11th we found that these young ones had succumbed. Probably this is the fate of the majority of late broods. I believe there would be no late eggs or second broods at all were it not that so many of the first are destroyed and eaten by their neighbours.

The number of Skuas increased largely day by day as we killed seals round the ship for food, and there were at no time less than twenty or thirty flying over the dog-kennels on Hut Point. At the end of March they began their migration northward, and finally disappeared on the 30th, to be seen no more till the following spring. This Skua is of a sociable disposition, notwithstanding its cannibal tendencies, feeding, nesting, and basking in the sun in groups. It is, moreover, a very cleanly bird, and repeated search failed to reveal an external parasite of any kind. It is particularly fond of bathing in the thaw-water pools among the hills where the snow is melted by the heat absorbed from the sun's rays by the adjacent rocks. Round and in these pools a group of Skuas might always be found, and the abundance of their feathers at the edge testifies to the habit (*see* fig. 42, p. 68). In the adjacent snow their tracks are found, and here and there a pattern in the hardened surface that might puzzle anyone who had not watched them there (*see* fig. 40, p. 56). Just ahead of two footmarks is a fan-shaped series of linear scoop-marks, made by the bird's beak as it squats comfortably on the snow and proceeds to satisfy its thirst by eating it.

The Skua has no doubt good sight, but its sense of smell must be little short of marvellous. When on a sledge journey to the south with Captain Scott, on Ross'

Great Ice Barrier, we camped in lat. 80° 20′ S., about 170 miles from open water, and 150 miles from the nearest spot which we knew to be frequented by the Skuas, we were surprised one day to see a bird hovering round our camp, till we realised that the wind was southerly, and remembered that the night before we had killed and cut up one of our sledge dogs to feed the others. Nothing but the scent of blood could have brought the bird those many miles. This was on December 10th, and the same thing happened again on our return when the wind was once more southerly, and the scent of blood was carried about the same distance, and brought on this occasion two Skua Gulls to our camp. They remained with us two days and disappeared, leaving us to finish our journey home alone. Three months of solitude were spent on this journey, so completely devoid of life that this was the only bird or beast of any sort that came to break it.

On March 5th, in McMurdo Sound, we shot the first of the year's brood upon the wing. It had the straw-coloured ring on the neck very imperfectly marked, and was otherwise very dark all over. Its legs were piebald, black and pale bluish white, in patches persisting from the normal colouration of the nestling (see Birds, Plate xiii., fig. 5). This condition of things, however, was not a constant characteristic of the first year's bird, for, in going through some three hundred of the adults that we shot for consumption during the ensuing winter, no fewer than 20 per cent. were found to have piebald legs. Moreover, on once more reaching the Auckland Islands we saw precisely the same piebald legs in an individual of the larger and darker species, *Megalestris antarctica*, and precisely the same thing may be seen also in one of the examples of *M. antarctica* which are now to be found in the Zoological Society's Gardens at Regent's Park (July, 1906). Such facts may have little significance, but they are worthy of record as evidences of individual variation. This particular case is possibly a reversion, and suggests that at some previous stage in their history the Skuas were paler birds than they are at the present day, a suggestion one may gather from the colouring of the chicks.

The inability of these birds to appreciate danger is often very remarkable. Before their departure we took heavy toll of their numbers to supply ourselves with fresh meat, and a change from seal flesh during the approaching winter. There was little difficulty in procuring more if the gunner was successful in dropping one, as the rest immediately collected to see what was going on, their curiosity only increasing with the fall of a second or a third. It is but fair to add that nothing, save the necessity of taking every possible precaution against the scurvy which had appeared in our ship's company, would have induced us to take such an advantage of their ignorance of danger. Their courage as thieves led more than once to much amusement. On one occasion a fish-trap hole was used by two of our men for fishing with hook and hand line, and the proceeds of the sport were rapidly thrown behind them, as one after another of a passing shoal of fish was landed. But, alas! when the shoal was gone, and they turned to take count of all that they had caught, there were only a few satisfied-

Fig. 41. McCormick's Skua (*Megalestris maccormicki*).

Fig. 42. McCormick's Skuas, bathing in a thaw pool.

*To face p.* 68.

looking Skuas behind, which heavily took flight as the fishermen rose suddenly to their feet. On another occasion, when cutting up a seal, we held out scraps of blubber which were taken from our hands by Skuas on the wing. If any part of the seal was to be kept we had to be careful to protect it. When the Sea-elephant was killed, its tongue and eyeballs were set apart to be preserved in spirit, but both disappeared while the rest of the skinning was being completed. Not only this, but a heavy pilot cloth jacket had been dragged ten yards away by Skuas that disputed its possession, and the sealskin sheath of a knife, about two feet long, was last seen hanging from the mouth of a Skua as it flew away to sea. Nothing is sacred and nothing safe from such clamorous thieves, and more than once they paid heavily for their pluck and curiosity.

I have mentioned below the fighting that occurs at times between nestlings that have but just emerged from the safety of their eggshells. This instinct is by no means confined to the young. The old birds were always game to fight, and nothing more was needed than to find themselves at close quarters in captivity, when the matter was at once fought out. McCormick's Skua chooses for its nesting site the northern or north-eastern face of some gravel-covered hillside, talus, or moraine cone, where the snow has either never settled on account of the winter winds, or from which it has been banished by the summer sun. We were able to inspect a score or more of their nesting colonies. They breed almost invariably in groups or colonies, with the nests only sufficiently widely separated to avoid unnecessary collision, which between birds of such strong thieving and criminal tendencies leads to awkwardness. Often the colony is situated close to and even mingling with a rookery of Adélie penguins. This is the case at Cape Adare, where the Skuas nest on the screes and upland heights of the higher ground in close companionship with the Adélie penguins that choose the high ground for their nests. A thousand feet above the moraine flat at sea level, where the majority of the penguins nest, may be found in close proximity both Skuas' and Penguins' nests with eggs and young. Again, at Cape Crozier the Skuas were collected in a nesting colony on the *débris*-strewn slopes of Mount Terror, overlooking many thousands of Adélies' nests. So also at Wood Bay and at Cape Royds. The last-named rookery, one of the smallest Adélie penguin rookeries we saw, was, strange to say, the largest of all the Skuas' breeding colonies. Literally scores of nests could be discovered during a day's tramp over the rocky cape. Nowhere flat, this little peninsula was extremely rugged, both from the irregular weathering of a hard volcanic rock, and from the fact that over it has run at some long distant period a huge ice-sheet, which has scooped it out into little hills and valleys and terraced it with moraine heaps. Each of these little hills or its adjacent valley was occupied by a pair of Skuas, and each little rise overcome in a morning's walk from the camp laid one open to the noisy attention of another pair.

Round and round one's head the one bird wheeled with a shrieking clatter, every now and again dashing down as though to strike. From time to time the blow took effect, and sometimes took one's cap off. Occasionally one might be surprised by a sudden blow on the forehead, but always, and as far as I could judge

without exception, it was given with the wing, and the claws were never used in the attack. While her partner was thus doing his best to frighten off the intruder, the sitting bird was loudly and persistently advertising the exact position of the nest, nor would she leave her post till we had come, sometimes, to within a yard or two.

The bird's cry is much like that of other gulls, a loud and anxious rapidly repeated cry, and very harsh. But the cry of the fledgling is very different. At Cape Adare I thought for some time that there must be a bird of the sandpiper type about, for I constantly heard a liquid, melancholy whistling trill. By degrees, however, it brought me to a fledgling Skua, which was just beginning to use its wings for flight. I saw it whistling with a most musical note, wholly unlike the harsh cry of the adult.

The bird makes no attempt at concealment, though its colour as well as the colour of its eggs might be considered to be specially adapted to the nature of the ground, but with such habits as the Skua's there is obviously nothing in it. Even when the bird is away from its nest, one has but to climb a little rocky hillock, and somewhere in the hollows under one's eye will be apparent two eggs in a shallow scooped-out nest, easily visible even at a distance of ten or twenty yards. There is never any attempt at nest-making other than the shallow depression in the gravel on which the eggs are laid. Once only I found a little collection of the Adélie penguin's tail feathers laid in the hollow, as one occasionally finds a little twig or a few bents laid in the hollow of a Peewit's nest,* but as a rule in a Skua's nest there is nothing at all. We never found more than two eggs in a nest, and in a certain number of cases in every rookery one egg is considered sufficient for incubation, the other doubtless having been stolen by a marauding neighbour. In many cases there is to be found in company with a normal egg another with a much thinner shell and a pale bluish ground, but with little or no marking. Sometimes a thin-shelled egg may be ringed round the upper third by minute and crowded dots and speckles, but be lacking in the characteristic blotches of the normal egg. These I took to be the results of an effort to replace a stolen egg, the amount of shell and colour that the bird is able to secrete being nearly exhausted in the production of the first two eggs. In one nest I found a normal egg in company with another the size of a Blackbird's.† All round the colony, in addition to the empty shells of sucked penguins' eggs, are to be found the shells of Skuas' eggs bearing similar evidence of theft and suction.

A very favourite nesting site in McMurdo Sound was a group of moraine-covered islands on the western side, now known by the name of Dailey Islands. At Dellbridge Islands, also, on the eastern side of McMurdo Sound, we procured large numbers of Skuas' eggs, but neither here nor at the Dailey Islands did the rule hold that Skuas always breed near penguins, for in each case they were quite alone.

* Peewit = *Vanellus vulgaris.*
† Blackbird = *Turdus merula.*

We arrived at our winter quarters about the end of October, but the Skuas did not begin to lay their eggs till the beginning of December. In 1902 the first egg was taken on December 9th, and in 1903 on December 2nd. The majority are laid by the middle of December, and then ensues a period of four weeks for incubation. On New Year's Day the first young Skuas were hatched, three nests had two chicks each just hatched, and two nests had one egg hatched in each. The chick emerges with a well-developed egg scale on the beak, which it sheds in a day or two. It is a mere ball of pale slate-grey fluff, with pale blue beak and feet and legs; the grey of the down has much more blue in it than buff, and herein seems to lie a distinctive character between the young of McCormick's Skua and the young of the more northern Antarctic Skua. But it is well, in judging of slight differences in the shade of colour in museum specimens, to remember how soon the bluish colour disappears, and is replaced by a buff or brownish-yellow tone, resulting from the almost unavoidable absorption of a certain quantity of fat from the skin.

By the middle of January it is difficult to find an egg unhatched, though in Granite Harbour we found eggs so late as January 20th. The paired adults are very friendly and have an obvious mutual care for one another and their chicks. As we were able to watch them from our tent door, camped out on Cape Royds in January, 1904, we saw much that otherwise might have escaped notice. The pair that hatched out their young within a few yards of our tent never got accustomed to our proximity. Each time as we left the camp or returned to it we were assailed with an angry clamour. Nevertheless, the chicks were not removed, nor were they led away. They were able to run at once on emerging from the egg, and the two young ones soon got separated from one another. The parents seem to know from the first that too much care and coddling will unfit them for such a rigorous climate. Consequently one rarely sees the parent sitting on the chicks. She will be somewhere close to them, but they themselves will be generally some feet away from her, sunning themselves or taking shelter under the lee of a neighbouring rock. The fact is that these two little chickens in their nest do not agree. I have seen them a few days after hatching fight tooth and nail with one another over some trivial bit of food, locked each to the other by every claw, and fighting with loud squeals as they used their tiny beaks. They are not fed, as are so many birds, directly from the parent's bill or pharynx, but from the first they pick up for themselves, and I have seen the parents put bits of regurgitated fish and crustaceans on the ground for them to peck, thus treating them exactly as a fowl of the barnyard treats her chickens.

It is a noticeable fact in connection with this bird that only one of the two hatched in a nest survives. This is connected with the tendency of the young to wander and get separated, and also with their tendency to fight, and with the instinct which teaches the parent to be chary of giving them too much nursing. The consequence of all this is that while the mother is engrossed with one, the other

wanders out of reach and is sooner or later snapped up by a hungry neighbour. It is a fact, at any rate, that though two young ones are almost always hatched, one is invariably missing after a few days or a week. This point we noticed at Cape Adare in 1902, and proved conclusively when we had better opportunities for watching at Cape Royds in 1904. That the chicks are eaten in every case by their own kind is probable, though this was actually seen but once; the fact remains that one of the two mysteriously disappears out of every brood, and the corpse is very seldom found.

From the end of October to the beginning of April may be considered the six summer months given up by this bird to the business of reproduction. It inhabits during this period the most southerly part of the globe that can by any bird or beast, including man, be looked upon as habitable at all. No bird goes farther south than this, and very few so far. When the young were well feathered and fully capable of looking after themselves, they appeared with their elders round the ship in search of scraps and refuse. They are easily known by their very dark and uniform plumage. They have not got the bleached and whitened feathers that give their elders at the end of summer a characteristic hoary look, nor have they the straw-coloured ring round the back of the neck that becomes prominent in the second year and increases then with each year. The changes in plumage from the slate grey downy nestling to the adult are much as follows. The first thing noticeable before the feathers of the wing are properly developed, is a gradual blackening of the pale blue feet from the claws upwards, a blackening which gradually creeps up the toes and webs with a definite line of demarcation, extending by degrees till the feet and legs are black to the feathers at the tibio-metatarsal joint. Here, in the young just about to take the wing, there is still a bright blue patch of skin, but by March the legs and feet are black all over. The down has by this time been exchanged for a uniformly dark and soft mouse-grey plumage, which gradually becomes more brown by the removal apparently of the soft loose ends of the barbs by wear and tear. The bird now in its first year's plumage has no trace whatever of the golden straw-coloured band upon the neck; this begins to appear at about the age of ten or eleven months.

The following table gives at a glance the general movements of McCormick's Skua throughout the year in McMurdo Sound.

| | 1902. | 1903. |
|---|---|---|
| The first bird arrived ... ... ... ... | Nov. 3 | Oct. 25 |
| Birds obviously pairing ... ... ... | — | Nov. 25 |
| First egg discovered ... ... ... ... | Dec. 9 | Dec. 2 |
| First chicken hatched ... ... ... ... | — | Jan. 1 |
| Young are first able to fly ... ... ... | Mar. 5 | Feb. 24 |
| The majority have gone north ... ... | Mar. 25 | Mar. 20 |
| Last bird seen in McMurdo Sound ... ... | Mar. 30 | Apr. 7 |

The food of the McCormick's Skua consists of a variety of things, most of which have already been mentioned incidentally.

In the early days of November when Weddell's Seals are giving birth to their young, the Skuas are ready scavengers, and make short work of the placental refuse.

Then, too, they hunt for themselves at sea and on the shore, picking up anything they can find in the shape of fish and crustaceans. They also hunt birds of other species, petrels, for example, and force them to disgorge what they have eaten. This they also do with one another. They are particularly partial to the eggs and young of the Adélie Penguin, and it is their taste for these that in most cases determines their choice of a nesting site.

The Skuas' real harvest begins as soon as the Adélie Penguin lays its eggs, and the abundance of empty shells about a rookery would be sufficient proof if other testimony were absent. But the Skua even robs its own kind, and in a nesting colony of some 20 or 30 birds, the number that have apparently lost their eggs, or one at least, by robbery is always fairly large. I have seen a Skua dash down upon an unprotected nest—a Skua's nest—to pick up an egg with its bill with hardly a moment's pause, one might almost say that it was done while on the wing, as the avenging owner of the nest was down on the intruder like a flash, and the stolen egg dropped from a height at our feet disclosed the remains of a half-incubated chick.

That "dog won't eat dog" is untrue in the south, not only of the sledge-dogs but of the Skuas. Mr. Ferrar gave me a further instance. Near the rookery we killed a Sea-elephant on the beach, and on cutting him up were surrounded by some dozens of skuas, which were soon sitting on all the small headlands around us gorged with bits of blubber. Notwithstanding this abundance of a very favourite food, a nestling Skua which had wandered to the beach was seen, seized, and carried out to sea by one of the Skuas, followed by a clamouring crowd, all eager to rob the owner of its prey. It is when the Adélie Penguins have hatched their eggs, however, that the Skua has least trouble in procuring his food. Pouncing upon some unprotected young penguin he attacks its eyes, and soon has the victim at his mercy.

Hanging round the rookery, with the unmistakable look of a thief, the Skua will run up to a chicken almost as big as himself, drag it by degrees away from the more crowded part of the rookery, and then gradually worry it to death; eventually tearing a ragged hole in the skin of the back over the kidneys,* which are generally the first, and often the only parts that are touched. The penguin chick pipes his loudest, but the old birds standing round take very little notice. Occasionally one in passing will make a run at the Skua and drive him off for a moment, but the chick is separated from the rest, and the old penguin has no mind to stop and shelter him, so back the Skua comes to complete his work. Literally, in a rookery such as that of Cape Cròzier, one cannot walk ten yards without coming on a dead penguin chick. Many of these, as one would expect in a climate where decay is very slow, are dried and flattened mummies, trodden down and trampled into the stones and guano that cover the ground. But an enormous proportion are seen to be fresh victims, if one visits a rookery in January, when the Skuas have not only themselves but their young to feed.

* *Cf.* Potts, in 'Zoologist,' 1881, p. 298, on the Kea.—F. J. B.

Skuas are generally to be found in the neighbourhood of seals, in the hope of getting scraps of fish and offal. Round our ship they lived on any refuse they could find, gorging themselves mainly with seal's blubber, but swallowing everything that was novel to their sight. On one occasion, the stomach and œsophagus of a bird that was shot were completely occupied by two sheep's ribs, the bones of two very lengthy chops from some of our frozen mutton.

I have said above that the wide range of colour in McCormick's Skua depends mainly on the bleaching of the feathers, which is excessive during the summer months, and on the moult, which occurs irregularly during the summer, chiefly at the latter end of January and in February. When the birds first came south to McMurdo Sound in November, it was exceptional to see one in the bleached and weathered phase of plumage. Most of them were then in the dark plumage which had been assumed towards the end of the preceding summer, and the exposure undergone during the darker months of winter had not left very much trace of wear and weathering.

But amongst the number of dark birds which characterise the month of November (of which No. 75 and No. 83 are typical examples), one is occasionally seen (No. 87, for example) which carries the same plumage that it had during the previous winter, and consequently appears very white and weathered on the head, breast and mantle.

In December the birds are nesting, and one may note the light and the dark phases paired together. One may also still see the exceptionally weathered birds in a plumage now completing its second year, and these may be of either sex. But the more usual phase is the darker one with slightly weathered plumage, since the summer sun rapidly takes effect in bleaching the plumage which has already stood the winter's wear.

In January all stages of weathering may be seen, and every intermediate phase as well, produced by moult. Light, dark and mottled, can all be easily procured, though by the end of the month the bleached birds predominate. Of the eight skins procured this month six were much weathered, two were moulting, and one had already completed the moult.

In February one has still a mixture of very white and dark birds, the dark phase perhaps predominating, as the majority of birds have shed their whitened plumage, and are now as dark as the young which may be seen occasionally on the wing.

In March once more almost the same condition holds good that is to be seen in October, though there is a greater freshness in the dark brown of the moulted adults and the young. Here and there, again, as in October, one may see a bird which has not changed its plumage, showing pale and weathered amongst the moulted birds.

Even the oldest adults are dark when freshly moulted (as, for example, No. 76), and apart from evidences of age in the beak and claws, there seem to be no definite age characteristics except, possibly, in the straw-coloured collar, which has been considered of some value in the distinction of the species. The development of this golden collar varies a good deal; in some birds it is very marked, but in others absent, and

it is in the older birds, both male and female, in the white and weathered phase of plumage, that the golden tips which do not fade show to greater advantage.

In a young adult the pale straw-coloured tips of the dark neck feathers are hardly visible, and in a bird of the first year there is no sign of them at all (see, for example, Nos. 72 and 77). In No. 82, an adult male, not only is the golden collar a well-marked feature, but there are gold tips to many of the feathers of the head and crown.

I know of no differences in the colouring of this bird by which the sexes may be distinguished, but there seems to be a fairly constant though slight advantage in point of size in the female over that of the male.

| | Wing. | Tail. | Bill length. | Bill width. | Tarsus. |
|---|---|---|---|---|---|
| ♀ | 16·5 to 15·3 | 7·3 to 6·3 | 2·4 to 2·3 | 1·55 to 1·3 | 2·5 to 2·3* |
| ♂ | 16·4 to 15·0 | 7·4 to 6·3 | 2·4 to 2·2 | 1·5 to 1·2 | 2·5 to 2·2 |

Individual variations in the measurements taken from birds of the same sex may have a good deal to do with age, but they are considerable.

The average weight of three adult McCormick's Skuas was 3 lbs.

If the eggs of *Megalestris maccormicki* and *antarctica* are examined, something of the same difference in size will be noticed that holds between the birds. Thus in twenty-six eggs of *maccormicki*, not one reached the measurement of a full-sized egg of *Megalestris antarctica.*

In four eggs of the latter, taken on the Macquarie Islands, the measurements are as follows:—

| | |
|---|---|
| 8·1 × 5·1 | 7·55 × 5·1* |
| 7·65 × 5·0 | 8·1 × 5·4 |

while the measurements of eleven eggs of *Megalestris maccormicki* taken in McMurdo Sound are as follows:—

| | | | |
|---|---|---|---|
| Nest I. ... ... ... ... | 6·75 × 5·1 | and | 6·8 × 5·0 |
| „ II. ... ... ... ... | 6·6 × 5·0 | and | 6·7 × 4·9 |
| „ III. ... ... ... ... | 7·65 × 5·0 | and | 7·3 × 4·9 |
| „ IV. ... ... ... ... | 7·05 × 5·05 | and | 7·3 × 4·9 |
| „ V. ... ... ... ... | 7·35 × 4·9 | | |
| „ VI. ... ... ... ... | 7·15 × 5·0 | and | 7·35 × 4·9 |

Those measurements which are underlined are of the more uniformly coloured eggs, with thinner shells and but few spots or blotches. I believe, as I have said above, that they are the result of an effort to replace a stolen egg by a third.

It is interesting to note in several of the clutches taken from a single nest, that the distinct types mentioned by Dr. Sharpe in the Report on the 'Southern Cross' collections, were to be found, not sorted one with another, as might have been expected, but so that in the same clutch an egg of the brown type would be found with an egg of the greenish or olive-grey type, showing that examples of each of the various types of egg may be produced by the self-same bird.

Of the difference between the nestlings of these two species of Antarctic skua, I can judge only by what has been reported of the young of *Megalestris antarctica*

* Inches, *teste* R.B.S.

by others, and by what can be seen in the skins of that bird in the British Museum collection. We had no opportunity of obtaining fresh examples of the young of *Megalestris antarctica*, but from all accounts it would appear that the tone of the downy plumage in *maccormicki* is much more bluish than it is in the nestlings of *antarctica*, and it would be interesting to know whether the feet and legs and bill in life show any corresponding divergence from the distinctly blue colour in McCormick's nestlings (see Birds, Plate XIII., Figs. 1 and 2).

This is a point which can only be settled by reference to fresh specimens, for the nestlings of McCormick's Skua which were brought home by the 'Southern Cross' have altered from bluish grey to the brownish tone they now possess, and no doubt the skins of nestlings of *Megalestris antarctica* have altered in a similar manner.

## OCEANITES OCEANICUS.

### *Wilson's Petrel.*

*Procellaria oceanica*, Kuhl, Beitr., p. 136 (1820), ex Banks' Icon., No. XII.

*Oceanites oceanicus*, Sharpe, Phil. Trans., CLXVIII., (1879), p. 132; id. Rep. 'Southern Cross' Coll. (1902), p. 139, *ibique citata*; Eagle Clarke, Birds of South Orkney Ids., Ibis, Jan., 1906, p. 166, Pl. X., fig. 2.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 90, ad. sk. ♂, Jan. 9, 1902. Cape Adare.
Shot at entrance to burrow, in which were Nos. 91 and 92.

No. 91, ad. sk. ♂, Jan. 9, 1902. Cape Adare.
Caught on the nest with No. 92.

No. 92, ad. sk. ♀, Jan. 9, 1902. Cape Adare.
Caught on the nest with No. 91.

One egg, newly laid, Jan. 9, 1902. Cape Adare.
Taken from the same nest as the above three birds.

The colour of the soft parts is as follows :—

Bill, entirely black.
Iris, dark brown.
Legs and toes, black.
Webs, black at the free border and black also along the sides of the outer digits, but otherwise bright orange from the base of the first phalanges to a point level with the middle of the second phalanges.
Claws, black.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 6, ad. sk. ♂, Nov. 25, 1902. 67° S, 179° E.
Also an adult skeleton.

FROM Mr. Howard Saunders I take the following notes as to the range of Wilson's Storm Petrel :—

It has been recorded from Louis Philippe Land; from Deception Island in the South Shetlands; probably also from South Georgia, under the name *Oceanites melanogaster*, by Steinen; from Gerlache Strait by the 'Belgica,' and from Cape

Adare by the 'Southern Cross,' where we are told by Mr. Hanson that eggs were secured, but no live young ones; though from the multitude of the dead young ones in their old nests, it appears that very many perish every year. Kerguelen is given as the first breeding place made known in 1874.

Quite recently the Scottish Expedition has returned with eggs from the South Orkneys, and the following notes are given in Mr. Eagle Clarke's paper on the bird in these islands (Ibis, January, 1906, p. 167). "In the autumn of 1903 it was last seen on March 23rd. . . . It was never observed during the winter months, and did not appear until late in the spring, namely on November 11th, being the last of the summer visitors to arrive. . . . On December 11th the first egg was obtained. . . . There was no attempt at nest making . . . and both eggs and dead young birds of previous seasons were numerous in the tenanted holes containing the fresh eggs."

Quoting once more from Mr. Howard Saunders: "After the breeding season Wilson's Petrel wanders widely; and owing to the fact that it has been often observed on the coasts of Western Europe, including the British Islands, as well as on those of America up to Labrador, some ornithologists have assumed that it breeds on the islands of the North Atlantic. Of this there is not the slightest proof; on the contrary, some of the birds obtained between the spring and autumn of our Northern Hemisphere are in moult."

"Both sexes," says Mr. Hall (Ibis, 1900, p. 19), in speaking of the nesting habits of this bird upon Kerguelen Island, "take turns at incubation, and about 8 p.m. the 'night shift' comes in from the sea to go on duty, when the relief is marked by loud croakings; and few birds are to be seen over the land in the day-time."

This point is no doubt the same as that commented upon by Mr. Eagle Clarke in the following words: "From 7 to 11 p.m. these birds flitted about the cliffs and over the head of Scotia Bay in great abundance, and in striking contrast to their habit in the day-time, when only occasionally was one to be seen on the water, though there were probably many at sea off the islands."

The bird is obviously migratory, coming far south to breed, and wandering over every ocean when its duties in that way are completed. We first met with it on November 7th, in 51° 16′ S. lat., 108° 5′ E. long., just before dipping south to make a short excursion in the ice pack on our way out to New Zealand. On the 8th we again saw several. After that not more than one or two till November 16th, when we were in touch with ice. The bird was with us each day in the ice and out of it, and northwards till we reached Macquarie Island on November 22nd. Between Macquarie Island and New Zealand we did not see it, nor yet until we sighted ice after leaving New Zealand on our voyage to the South, did this bird again put in an appearance. On January 2nd and during the week that we spent in making our way through the pack they were with us night and day, flitting over the icefloes like so many House Martins.*

* House Martin = *Chelidon urbica.*

On January 9th we made a landing on Cape Adare, and had some hours which we occupied in hunting for this and other birds' nests. It was presumably late for nests, but we were lucky in at last locating one. The birds were to be seen hovering round the mouth of crevices in the rocky side of the cliff, often settling close by for a few seconds, and then sailing in short circles round it, reminding one strongly of the movements of a House Martin at its nest under the eaves of a country barn.

Two of these crevices could not be reached, but soon we saw a bird hover round and settle upon a large boulder. Hunting about for a burrow underneath, we caught the sound of twittering, and traced it to a kind of mouse-hole. This by dint of long and tedious picking with a sheath-knife, we enlarged till it admitted an arm up to the shoulder. The work was laborious, as the floor of the burrow was hard black ice and grit, but eventually we reached the nest. At the end of the little tunnel was a chamber containing a very comfortable nest thickly lined with Adélie Penguins' feathers, and in it a somewhat remarkable collection. First we brought out an adult male alive, then an adult female ; then two eggs, one clean and newly laid, the other old and rotten, and under all another dead and flattened adult *Oceanites.* Outside, as we worked, a fourth bird was hovering, which, when shot, proved to be an adult male. It has been long known that with this species the nesting burrow is often used by more than a single pair. The fresh egg was preserved, the rotten one fell to pieces, and the three birds were preserved.

Not a day now passed in our summer cruising on which we did not see a few Wilson's Petrels. Never in large numbers, they were, nevertheless, never absent, and it was not until February 7th that we saw the last, in 1902.

At the approach of winter they disappeared from the southernmost regions, and no doubt migrated north. Though the ice of Ross Sea was many times broken up by storms during winter and early spring, the little Wilson's Petrel was not to be seen in McMurdo Sound from the end of February to the middle of December. In December and in January of 1903 to 1904, while we were camped on the sea ice under Dellbridge Islands, we saw quite a number of them, but though the rough volcanic rocks and boulders were apparently much frequented, we found no nest there. Nor could we find them nesting at Cape Royds, which seemed more suitable, being some miles nearer to open water and their food supply.

The burrows are not very difficult to discover, for one's attention is drawn to them by the habit the bird has of hovering round the entrance in the evening hours, and settling there without actually going in, and also sometimes by the twittering of the bird within. They are often quite inaccessible without a rope even when located, but on the other hand they may be almost on level ground.

The flight of the bird is peculiarly attractive in these barren wastes of snow and rock, chiefly perhaps, from its resemblance to the flight of the familiar martin, for it flits here and there exactly as though in search of insects on the wing. Occasionally it sails on outstretched wings. The power of flight must be very wonderful, for it

seems to spend its lifetime on the wing. On more than one occasion it was seen by sledging parties on the ice plain of the Great Barrier, some sixty miles from open water (78° 30′ S. lat.), but always on the wing, and apparently never tired.

Its food, consisting of minute crustaceans, is picked up from the surface of the water on the wing. Flitting about from wave to wave, the little Petrel delicately treads the water to steady itself a moment, while it picks up a tiny morsel.

As we left the southernmost area, we saw it each day from February 19th to March 3rd; but on that day, when amongst the Balleny Islands, we saw the last of the icebergs and with them the last of *Oceanites.*

Five days later on, when in S. lat. 61°, we fell in with *Cymodroma grallaria*, and from that time onwards they became more and more abundant, and apparently took the place of *Oceanites.*

## FREGETTA MELANOGASTER.

*Thalassidroma melanogaster*, Gould, Ann. and Mag. Nat. Hist., xiii. (1844), p. 367.
*Fregetta melanogaster*, Gigl., "Faun. Vert. Oceano," 1870, p. 38; Sharpe, Rep. 'Southern Cross' Coll., (1902), p. 141, *ibique citata*; Eagle Clarke, Birds of South Orkney Ids., Ibis, Jan., 1906, p. 168.

This bird we met first on September 1st, 1901, in the Atlantic Ocean. There were a number of them, and they kept about our wake and stern quarters, rarely flapping their wings, but sailing up and down close over the waves. The distribution of black on the under parts, extending from the chin to the tail, can be easily made out when watching the birds upon the wing. The white of the axillary region joining with the white on the rump and under wing coverts does not meet beneath on the breast as it does in *Cymodroma grallaria.* We saw the bird fairly constantly in the South Atlantic throughout September and on to the 16th of October in large numbers, twenty or thirty following in our wake with their very characteristic flight, halting and then darting forward as though they had dipped their toes in scalding water. Again on October 20th they were exceptionally plentiful, and a few appeared almost every day until November 16th (61° S. 140° E.) when they left us as we came within sight of ice, and were not seen again.

Although they generally fly in the wake of the ship they also constantly travel round her, and may often be seen on the bows. We obtained no specimen. The bird is a great wanderer, and though it has been taken in Kerguelen Island, New Zealand, and has been reported from the Southern Oceans generally, it has also been taken as far north as the Bay of Bengal and the Tropic of Cancer in the North Atlantic, and quite recently has been found by the Scottish Antarctic Expedition, breeding on December 5th, so far south as the South Orkney Islands. (Eagle Clarke, *op. cit.*, p. 168.)

## CYMODROMA GRALLARIA.

*Procellaria grallaria*, Viell. N. Dict. d'Hist. N. xxv. (1817), p. 418.
*Cymodroma grallaria*, Baird, Brew. & Ridgw., Water Birds of N. Amer., ii. (1884), p. 419 ; Salvin, Cat. B., Brit. Mus. xxv. 1896, p. 366, *ibique citata.*

This petrel is to be recognised on the wing mainly by its small size and white belly, the chin, throat and tail alone being black on the under part. We obtained no specimens, though we saw it on several occasions. On September 18th, 1901, we had several in our wake, and again on September 20th we saw them continually dropping to touch the water with one foot, steadying themselves while they daintily took their minute crustacean food from the surface of the water. At these times their tails become much hollowed out on the dorsal surface, so that each half is at right angles to the other.

We saw the bird again on September 24th, 1901 (37° S. 8° W.) in the South Atlantic, and on November 11th, 1901 (52° S. 127° E.), in the Southern Indian Ocean, when a few were following in our wake, but we saw none in the winter months on our voyage home, either in the South Pacific or Atlantic. It is said to range generally over the seas of the Southern Hemisphere, and northward to the coast of Florida.

## PUFFINUS GRISEUS.

### *The Mutton Bird.*

*Procellaria grisea*, Gmel. Syst. Nat. i. (1788), p. 574.
*Puffinus griseus*, Finsch, J. f. Orn (1874), p. 209 ; Salvin, Cat. B. Brit. Mus. xxv. (1896), p. 386, *ibique citata.*

Material in 'Discovery's' Collection.

No. 110, ad. skin, ♀. March 24, 1904. Laurie Harbour. Auckland Islands.
Also two specimens in formalin from the same locality.

Colouring of the soft parts :—

Bill, wholly black, but with a narrow thread-like white line at the base of the upper bill.
Iris, very dark brown.
Legs and toes, black on the outer surface, but lilac or purple on the inner surface.
Webs, blackish.
Claws, black.

This bird we observed in large numbers at the mouth of Laurie Harbour, where it was to be seen in immense flocks occasionally in March, feeding upon an orange-red *Euphausia*. Its method of fishing was typical of the shearwaters, as it would suddenly drop into the water and disappear with extended wings, appearing shortly after with the wings still fully extended to rise and repeat the same manœuvre constantly. We saw large flocks of what we presumed to be the same bird in the open sea off New

Zealand and the neighbouring islands. We found it to be excellent eating, though we had *Anas superciliosa* on the table at the same time with which to compare it. We also fully appreciated *Megalestris antarctica* and *Phalacrocorax colensoi*, neither of which was much inferior to the Grey Duck above mentioned, although that bird is most highly esteemed in New Zealand and Australia for the table.

## PRIOFINUS CINEREUS.

### *The Great Grey Shearwater.*

*Procellaria cinerea*, Gmel. Syst. Nat. i. (1788), p. 563.

*Priofinus cinereus*, Gigl. Faun. Vert. Oceano, 1870, p. 34; Sharpe, Rep. 'South. Cross' Coll. (1902), p. 142, *ibique citata.*

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 127, adult skin, ♂. Nov. 2, 1901. 46° 51′ S. 89° 28′ E.

Colouring of the soft parts :—

Upper bill, dark greyish horn, the latericorn pale and yellowish, and in some birds even bright yellow.

Mandible, greyish horn at the tip, but otherwise pale yellow, both on the cutting edge and on the sides, a darker line dividing these parts.

Iris, dark brown.

Legs and toes, grey or flesh grey.

Webs, flesh pink or even red by transmitted light. but otherwise grey, or flesh grey.

Claws, blackish horn.

The inside of the mouth is flesh red, the palate, fauces and tongue abundantly supplied with sharp horny papillæ.

*Priofinus cinereus*, the Great Grey Shearwater, is a very characteristic bird of the Southern oceans, considerably larger than the Cape pigeon, grey or bluish grey all over the upper parts, and white beneath; it may be seen occasionally in the ship's wake without drawing the attention of the casual observer. But one morning he will go on deck to find the ship followed by the bird, perhaps in hundreds. Very hungry or very greedy, they then afford much amusement as they drop suddenly beneath the surface of the water with their wings spread to seize some scrap of food. They unhesitatingly go completely under and reappear again with their wings still spread. We were visited by such a flock on November 1, 1901, in the Southern Indian Ocean. Having first seen it on September 25th, 1901, we had never had more than two or three with us until this flock arrived. Many of them were evidently moulting, as several of the smaller primaries were missing on either side. This exposed the paler part of the primaries still present, and gave the appearance of a white patch and a piece cut out from the centre of the wing. They may be caught and landed with stout thread entanglements, but ordinary thread should not be used, as it is apt to entangle the bird and break, leaving it disabled in the water. This large flock remained with us for

about a week, when it began to dwindle, and on November 12th, on our turning to go south, the birds left us altogether.

On our homeward voyage we saw one example of this bird on March 10th, 1904, in 58° S. lat., 164° E. long., and a large number from time to time between New Zealand and Cape Horn in June. But their numbers diminished as we neared South America, and we saw the last on June 24th. In the South Atlantic we saw it occasionally in numbers between July 23rd and 29th, when it finally disappeared. It ranges all over the Southern oceans, from 35° S. to the Antarctic Circle.

## THALASSŒCA ANTARCTICA.

### *The Antarctic Petrel.*

*Procellaria antarctica*, Gmel., Syst. Nat. i. (1788), p. 565.

*Thalassœca antarctica*, Coues, Pro. Acad. Nat. Sci. Philad., 1866, pp. 31, 192; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 143, *ibique citata*; Eagle Clarke, Birds of S. Orkney Islands, Ibis, Jan., 1906, p. 169.

Material in the 'Discovery's' Collection.

No. 7, ad. sk. ♂, March 2, 1904. Off the Balleny Isles. Moulting. Shows a mixture of light and dark feathers.

No. 8, ad. sk. ♀, Jan. 11, 1902. Off Cape Adare.

No. 9, ad. sk. ♂, March 2, 1904. Off the Balleny Isles. Newly moulted. Shows in rich contrast the pure white and dark chocolate brown.

No. 10, ad. sk. ♂, Jan. 11, 1902. Off Cape Adare.

No. 129, ad. sk. ♀, Nov. 16, 1901. Pack ice. 61° 46′ S. 140° 12′ E.

Nos. 163, 164, 165, ad. skeletons from Cape Adare.

The colour of the soft parts is as follows:—

Bill, blackish horn; the cutting edge of the mandible lemon yellow.

Iris, dark brown.

Legs, toes and webs, pale fleshy grey. The knuckles in an old bird, *e.g.*, No. 9, are marked with darker shades.

Claws, blackish.

Material in the 'Morning's' Collection.

No. 18. No label.

No. 22, Dec. 25, 1903. Ice pack. North of Ross Sea.

No. 24, ♂, Dec. 25, 1903. Ice pack. North of Ross Sea.

No. 4. No label.

No. 4, ♀, Dec. 25, 1903. Ice pack. North of Ross Sea. The chin and throat unusually white and devoid of the usual brown.

No. 34. Skeleton. Dec. 25, 1903. Ice pack. North of Ross Sea.

The breeding place of the Antarctic Petrel is still unknown. The bird seems to have been strangely scarce in the South Orkney Islands, though the Scottish Expedition obtained specimens in the Weddell Sea. Its range and distribution also appear to be

little known, though examples were brought home from the Antarctic seas by Dr. McCormick so long ago as 1842. The following notes on its wide occurrence in the southern oceans will therefore be of greater interest, proving as they do, conclusively, that the bird is just as much a regular migrant as *Priocella* or *Oceanites.* We observed it in June and July as far north as 53° S. lat. in W. long. 82°, and every bird we then saw was freshly moulted.

Having learned the details of this bird in England, it was not surprising that on meeting it in the Antarctic pack ice there should have been some doubt as to its identification. It required much faith to see in the richly piebald bird that appeared to be almost black and white against the icefloes, any semblance to the faded white and buff-brown specimen that was captured in the days of Ross. But the Museum specimen was not, as we found out later, altogether at fault. In life, also, the colours fade, and the rich dark marking of the first one we met was in reality a colour that very soon wears off.

It is most noticeable in the Antarctic birds how little their feathers stand the wear and tear of the summer season. The wind and weather, the alternate snow and sea spray, the continuous sunlight for several months in the summer, combine to give a bird a very different appearance before moulting to that which it will have when the moult is over. In the case of the Antarctic Petrel the change is particularly marked. It is marked also in the Skuas and in the Penguins.

The clean-moulted *Thalassœca* is a handsome bird, with head and back and wings deep chocolate brown, and pure white wing and tail coverts ; and after the autumn moult, when the young birds have gone north to the open ocean away from ice, one sees them in this dark plumage during the winter months between New Zealand and Cape Horn. In November they are still dark, but when the nesting season is over and the summer sun has done its work, the richness goes entirely and a pale buff colour takes its place. Then comes the autumnal moult in January or February, and the birds take on a mottled plumage, as one by one the almost black-brown feathers make their way out amongst the faded feathers of the head and back.

We met the bird in November of 1901, when we first sighted ice, in 62° S. lat. and 140° E. long. Two or three followed us a long way to the north again, away from the ice, but left us five days before we sighted the Macquarie Islands. They were in full dark plumage.

On our next journey southward a dozen or more met us as we again encountered ice in January. They had been roosting on a berg, and were in full moult, with primaries missing in the wings, and a mottled plumage of buff and black-brown feathers intermixed. Throughout the ice pack we had them with us, and on the 10th of January we saw them flying in a flock in a south-easterly direction down the coast of South Victoria Land. All that night and the following day we had flocks of them around us, some flying at great heights, turning and wheeling together at a given signal in contrast to the independent and irregular flight of a flock of Snow Petrels.

All were moulting, as one could see by the missing primaries of the wings. Several were caught on threads. They had been feeding on small fish and squids, the beaks of which formed part of the contents of their stomachs. On January 12th we lost them for a while, and saw no more till we found them in exceptionally large numbers at the extreme eastern edge of the Great Ice Barrier. Here in S. lat. 76° 50′ and W. long. 158° we discovered King Edward VII.'s Land, and the unusual abundance of *Thalassœca antarctica* may mean that they breed somewhere in the locality. There was no spot in sight, however, that could possibly have suited them; there were no rocky cliffs worth mentioning, and no land that was not buried in an undulating and almost unbroken sheet of snow and ice. Returning by this spot a few days later we were again surrounded by large numbers of the bird, but we lost them the next day entirely and as suddenly as we had before met with them on the same spot. They were not on passage, but were flying to and fro as though in the neighbourhood of their breeding place; more than this we cannot say. From that time onward for two full years in McMurdo Sound we did not see the bird, save once, when a single straggler passed the ship.

On our homeward journey, however, in 1904, we fell in with them on February 26th. We were then in pack ice, and on the 29th we saw large numbers and kept them with us as we passed between the Balleny Islands. They were not in flocks. Some were freshly moulted, but others had only just begun. One or two were caught on threads and landed. We finally saw the last of them on the day that we crossed the Antarctic Circle coming north.

I have mentioned that between June 22nd and July 4th this bird was seen in considerable numbers every day in the South Pacific Ocean. This throws some light upon their movements during the winter and extends their range. They are not so strictly ice birds as they were supposed to be, since they leave the ice for the open ocean in the winter months. We saw none in the South Atlantic. Upon their breeding haunts we can throw no light. It is possible that Scott Island may repay a search in January or December, and further exploration of King Edward VII.'s Land may some day disclose their eggs and young. At present, however, these still remain unknown, and the nesting place a mystery.

## PRIOCELLA GLACIALOIDES.

*The Southern Fulmar.*

*Procellaria glacialoides*, Smith, Ill. Zool. S. Afr. Aves. (1840), pl. 51.

*Priocella glacialoides*, Baird, Brewer and Ridgw., Water Birds N. Amer., ii. (1884), p. 375; Sharpe, Rep. 'Southern Cross' Coll., 1902, p. 145, *ibique citata*; Eagle Clarke, Birds of S. Orkney Ids., Ibis, Jan. 1906, p. 170.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 128, ad. sk. ♂. Nov. 16, 1901. Pack ice, 61° 46′ S., 140° 12′ E.

The colour of the soft parts of this bird is as follows :—

Bill, rosy pink, blackish at the tip on both mandible and maxilla. The nasal tubes and base of the mandible grey with a lilac tinge shading into rosy pink on the side plates.

Iris, rich brown.

Legs and toes and web all flesh grey with a strong pink tinge. Each knuckle on the outer digit of each foot marked blackish, as also to a slighter extent is each knuckle of the middle toe. A narrow blackish edging runs along the outer edge of each foot.

Claws, blackish.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 3, ad. sk. ♂. Nov. 25, 1902. 67° S., 174° E.

THE range of the Southern Fulmar in the Southern Hemisphere, as given by Mr. Howard Saunders, is very wide. It has been reported from the Cape, from the Pacific Coast of America, and as far North as Washington territory. Kerguelen Island is supposed to be a breeding place. It is abundant throughout the Southern Oceans, and has been obtained from Louis Philippe Land, Ross Sea, South Victoria Land, Ross' Barrier and the Weddell Sea ; also from the region westward along Adélie Land. Probably there is no quarter of the Antarctic in which it may not be found. The Scottish expedition reports it from the South Orkneys about the middle of February, and apparently in some numbers, just as we saw it in numbers off the Balleny Islands at the end of the same month. Nothing appears to be known of its breeding habits ; the Scottish expedition were unable to find it nesting, though they strongly suspected that it bred on the north side of Laurie Island ; nor were we in the 'Discovery' any more successful. I can only suggest the Balleny Islands as a possible nesting place, but if the bird breeds upon Kerguelen Islands it is much more likely that the more northern sub-Antarctic islands will prove eventually to harbour them. It must be considered a migratory bird, since it visits the southern waters of the ice pack during the summer months (December, January and February) and retires northward to the open ocean for the winter. Here we met it in abundance during June and July. We saw a very great deal more of this handsome bird in what may be called the sub-Antarctic region than in the true Antarctic. The first example was met with in 59° 18′ S. and 138° 2′ E., the day before encountering the pack ice on November 15th, 1901. They were rather more plentiful in the pack, and followed us for a couple of days after leaving it as we steamed north toward the Macquarie Islands, as far as 57° 25′ S. in 151° 45′ E. After this we saw no more till we once again entered the ice on the 2nd of January, 1902. A pair of birds met us with the first iceberg in S. lat. 67° 20′ E. long. 179°. The following days in the pack we saw three more, and then from January 6th in 1902 till February 27th in 1904, for two whole years, we never saw the bird. It keeps to the opeu ocean, and avoids the coast of South Victoria Land. In McMurdo Sound it never visited us, neither indeed did we see more than a

single individual farther south than lat. 68°; except on one solitary occasion it was not seen in Ross Sea south of the encircling belt of pack ice; but on the 27th of February, 1904, when we were on our way northward from Cape Adare, endeavouring to make the Balleny Islands by working along the coast by Cape North, a very heavy and extensive pack of ice forced us to stand out, and *Priocella glacialoides* became suddenly abundant. The following day we passed through the middle of the Balleny group of Islands and *Priocella* was more abundant than we had ever seen it elsewhere. It never flew in a flock. On the 3rd, 4th and 5th it was still abundant, but on the following day we crossed the Antarctic Circle and lost it as suddenly as we had found it.

All that has so far been said, however, gives a one-sided idea of its distribution. We reached New Zealand on the 1st of April and left on the 8th of June, to cross the South Pacific Ocean at a higher latitude than is generally taken, and to round Cape Horn. We were not so much surprised, therefore, when, on the 19th of June, we picked up *Priocella glacialoides* once again and two days later *Thalassoeca antarctica* as well. The latter we kept with us till within four days of Cape Horn, but *Priocella* much longer, for it not only accompanied us in very considerable numbers through the Straits of Magellan, but remained with us till July 12th, when we made Port Stanley in the Falkland Islands. It was not until July 22nd in S. lat. 49° and W. long. 52° that we eventually saw the last of it. Although we had both it and *Thalassoeca antarctica* with us almost throughout our voyage from New Zealand to Cape Horn, we saw no ice. The Snow Petrel alone of the southern birds, Penguins of course excepted, is an infallible indication of the close proximity of ice. Nowhere did we see any sign of *Priocella's* nesting place, though its sudden appearance in such large numbers in the neighbourhood of the Balleny Islands was suggestive. It was then, however, so late in the season that one would have expected to see young birds upon the wing, but in no case did we meet with a bird in any plumage but that of the apparently adult. It may be that the basaltic rocks of Scott Island, discovered in Ross Sea by the relief ship 'Morning,' are a breeding place for this petrel, and for the Antarctic Petrel too. From its position this is quite likely, and from the large number of birds seen in the neighbourhood in January one might well be led to think that the eggs and the young of these two birds may at some future date be found there.

## MAJAQUEUS ÆQUINOCTIALIS.

### *The Cape Hen.*

*Procellaria æquinoctialis*, Linn. Syst. Nat. i. (1766), p. 213.

*Majaqueus æquinoctialis*, Coues, Pro. Nat. Sci. Philad. 1864, pp. 118, 142; Sharpe, Rep. 'South. Cross' Coll. (1902), p. 146, *ibique citata.*

*Majaqueus æquinoctialis*, commonly known as the Cape Hen, first appeared on our outward voyage on September 27th, 1901 (38° S., 1° E.). It is easily recognisable

on the wing by the bright yellow of the bill and a white spot under the chin of an otherwise wholly black bird. When the bird is on the wing its bill appears to be comparatively long and thin, the legs and feet black and extending well beyond the tail give it even more of a cuneate form than it really has. It was an abundant bird in the South Atlantic, and increased in numbers enormously when we came in sight of South Africa, sitting in small companies on the water all around, and reminding us curiously in its colouring of the common Coot.* It was very abundant in False Bay, but we missed it in Simon's Bay. From October 15th onwards we had it with us on our way to New Zealand until November 9th when we lost it in 52° S. 120° E.

We saw no more of this bird until, on our return home, we were passing through the Magellan Straits. Here there were a few on July 7th; we had not seen one between the Straits and New Zealand. On July 28th, 29th, and 30th we saw a few in the South Atlantic between 30° and 37° S. in 32° W. Its flight is characteristic, the appearance of length and narrowness in its wings being much enhanced by its uniform blackness. The wings in flight have a very angular look: the bird is of a quarrelsome disposition, fighting greedily for scraps, and displaying the most ungainly spread of feet and straddled legs as it splashes with its rivals into the water. It is not known to wander farther to the north than 30° S. It breeds on the Crozets and in Kerguelen Island, according to Mr. Eaton, in a hole similar to a deserted rabbit's hole excavated in wet ground, with water standing (in early summer) an inch or two inches deep within the entrance, especially if it is in a slope near the sea. The nest is built of mud and pieces of plants arranged in the form of an inverted saucer, three or four inches high, hollowed out at the top. (Phil. Trans., 168 (1879), p. 121.)

## ŒSTRELATA LESSONI.

### *Lesson's Petrel.*

*Procellaria lessoni*, Garnot, Ann. Sci. Nat. VII. (1826), p. 54, pl. 4.
*Œstrelata lessoni*, Cassin, Pr. Ac. Phil. 1862, p. 327; Salvin, Cat. B. Brit. Mus. XXV. (1896), p. 401, *ibique citata.*

This is a bird which, from its characteristic marking and powerful flight, seldom failed to attract attention. Although it was never abundant, and usually occurred singly, flying wide of the ship and rarely daring to approach closely, its white head with the dark eye streak and the conspicuous W across its back and wings were easily to be seen at a distance. We first met with it in the Southern Indian Ocean (48° S. 96° E.) in November, and in the same month we saw it also in 59° S. 148° E. Also off the S.E. coast of New Zealand (44° 37′ S.) and on the outskirts of the ice (63° S. 178° E.) on January 1st. In such high latitudes it is by no means uncommon in March, and we saw it frequently onwards from March 4th (67° S. 155° E.) on our way to New Zealand from the south, more abundantly in this portion of our voyage

* Coot = *Fulica atra.*

than in any other. After keeping it with us day by day from New Zealand eastward to 144° W. 55° S., we suddenly and completely lost it, nor did we see it again during the remainder of that voyage. Its burrow, according to Mr. Eaton, is short and generally excavated in *Azorella*; it is as large as a rabbit's hole, dry, and with its entrance bestrewn with green shoots of *Acæna*. It breeds on the Kerguelen Islands.

## PAGODROMA NIVEA.

### *The Snowy Petrel.*

*Procellaria nivea*, Gmel. Syst. Nat. (1788), I., p. 562.

*Pagodroma nivea*, Coues, Proc. Ac. Nat. Sci. Philad. (1866), pp. 160, 171; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 148, *ibique citata*; Eagle Clarke, Birds of S. Orkney Ids., Ibis, Jan. 1906, p. 170, pl. iii., fig. 1 and xl. fig 1.

MATERIAL IN THE 'DISCOVERY' COLLECTION.

No. 11, ad. sk. ♀. Larger variety. Feb. 26, 1904. Off Cape North.
No. 12, ad. sk. ♂. Larger variety. Jan. 1, 1902. Off Cape Adare.
No. 13, ad. sk. ♂. Smaller variety. Feb. 4, 1902. Off the Great Ice Barrier.
No. 14, ad. sk. ♀. Feb. 4, 1902. Off the Great Ice Barrier.
No. 15, ad. sk. ♀. Smaller variety. Jan. 1, 1902. Pack ice, 68° S., 176° E.
No. 16, ad. sk. ♂. Smaller variety. Jan. 11, 1902. Off Cape Adare.
No. 17, ad. sk. ♀. Smaller variety. Jan. 11, 1902. Off Cape Adare.
No. 18, ad. sk. ♂. Smaller variety. Jan. 31, 1902. Off the Great Ice Barrier, 76° S., 207° 17′ E,
No. 166, adult skeleton. Cape Adare.

The colouring of the soft parts is as follows :—

Bill, black with a bluish tinge on the sides, and flesh-coloured along the cutting edges and at the gape.
Iris, very dark brown.
Legs and toes, webs, and claws all dark bluish black.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 5, ad. sk. ♀. Nov. 11, 1902. 68° S., 175° E.
No. 14, ad. sk. ♂. Ice pack. N. of Ross Sea.
No. 2, ad. sk. ♀. Ice pack. N. of Ross Sea.
No. 15, ad. sk. ♂. Ice pack. N. of Ross Sea.
No. 2, ad. sk. ♀. Nov. 28, 1902. 68° S., 175° 26′ E.

THIS beautiful Petrel is more strictly confined to the limits of the ice than any other. We first met with it in our short visit to the pack ice in S. lat. 61° to 62° and E. long. 140° on November 16th and 17th, 1901. But it was not until January 2nd, 1902 that we saw the bird in numbers, and then during the summer, cruising along the coast of South Victoria Land and the Barrier to King Edward VII.'s Land, it rarely failed to keep us company. Nothing could be more beautiful and less apparently fitted for the rigours of a storm-ridden climate, such as the Antarctic, than this little dove-like bird. It is the most constant companion of the ice, and whereas we saw the Southern Fulmar (*Priocella glacialoides*) and the Antarctic Petrel (*Thallassoeca*

*antarctica*) many times during our voyage home in the winter, when we were far to the north of the outskirts of the ice, we never once saw the Snowy Petrel away from its vicinity. It was abundant always in the pack ice, and it is there that the opportunity must be taken, if a good series of skins for a collection is to be obtained.

Our passage through the pack was unfortunately a rapid one, but from time to time we were able to procure examples and to confirm, at any rate, the observations previously made, that the measurements of this bird vary within large limits, irrespective of sex, and apparently also of local distribution ; though it seemed to me that there was a preponderance of the larger birds to the westward, where, unfortunately, we were not able to do much collecting, and that in the pack ice along the shores by Cape North and the Balleny Islands, the general build of all that we saw was bigger and stronger In the British Museum Catalogue the following measurements are given :—

| | |
|---|---|
| Total length ... ... ... ... ... ... | 14–16 inches (or 35·7–40·7 cm.). |
| Wing... ... ... ... ... ... ... | 9·8–11·1 inches (or 24·9–25·6 cm.). |
| Tail ... ... ... ... ... ... ... | 4·3–5·1 inches (or 10·9–13·0 cm.). |
| Bill ... ... ... ... ... ... ... | 1·4–1·55 inches (or 3·6–3·9 cm.). |
| Tarsus ... ... ... ... ... ... | 1·3–1·5 inches (or 3·3–3·8 cm.). |
| Middle and outer toes ... ... ... ... | 1·6–1·9 inches (or 4·1–4·8 cm.). |
| Inner toe ... ... ... ... ... ... | 1·3–1·5 inches (or 3·3–3·8 cm.). |

" Specimens differ greatly in size as indicated in the above measurements."

The variation in size is even greater than has hitherto been supposed The largest example in the present collection was obtained in the Ross Sea pack ice, while the smallest of all was obtained off Cape Adare ; their respective sizes may be seen from the following measurements :—

| | 'Morning.'—No. 15. | 'Discovery.'—No. 17. |
|---|---|---|
| Culmen ... ... ... ... ... ... ... | 2·6 cm. | 1·8 cm. |
| Wing ... ... ... ... ... ... ... | 29 cm. | 24·5 cm. |
| Mid toe ... ... ... ... ... ... ... | 5·5 cm. | 4·1 cm. |
| Total length ... ... ... ... ... ... | 39·5 cm. | 29·3 cm. |
| Tail ... ... ... ... ... ... ... | 15·2 cm. | 12·5 cm. |
| Tarsus ... ... ... ... ... ... ... | 3·8 cm. | 3·1 cm. |
| Inner toe ... ... ... ... ... ... ... | 3·8 cm. | 3·2 cm. |

and between these two extremes every gradation may be observed.

The following are measurements taken in the flesh from two examples of the bird which were captured in Robertson Bay :—

| | | |
|---|---|---|
| (*a*) | Total length ... ... ... ... ... ... ... ... | 34 cm. |
| | Total stretch tip to tip of wings ... ... ... ... ... | 78 cm. |
| | Girth at the shoulders ... ... ... ... ... ... | 20 cm. |
| | Bill from nasal feathers to tip ... ... ... ... ... | 18 mm. |
| | Bill from angle of mouth to tip ... ... ... ... ... | 35 mm. |
| (*b*) | Total length ... ... ... ... ... ... ... ... | 40 cm. |
| | Total stretch tip to tip of wings ... ... ... ... ... | 82 cm. |
| | Girth at the shoulders ... ... ... ... ... ... | 23 cm. |
| | Bill from nasal feathers to tip ... ... ... ... ... | 22 mm. |
| | Bill from angle of mouth to tip ... ... ... ... ... | 42 mm. |

On January 9th, 1902, we saw many of these birds flitting about the summit of the most inaccessible cliffs of Cape Adare. Farther down in Robertson Bay its eggs had been taken by members of the 'Southern Cross' Expedition in 1898 and 1899, and previous to this, in 1840, McCormick had obtained the eggs on Cockburn Island. We ourselves saw nothing of its nesting habits, our winter quarters being so far south that we were visited only by a few stragglers from time to time, not one of which remained to breed. The bird is a great wanderer, and was seen by several of our sledge parties on the Great Ice Barrier, some 70 miles to the south of open water.

After leaving Cape Adare we passed down the coast of South Victoria Land, and when in sight of the Possession Islands were visited, on the 11th of January, by large flocks of Snow Petrels, which flew about the ship, mounting to very great heights above the masthead. These flocks alternated, without mingling, with flocks of *Thalassoeca antarctica.* The latter would fly in unison, all turning at once like a flock of Starlings,* while the Snow Petrels, on the other hand, flew here and there independently in a mazy fashion, glittering against the blue sky like so many white moths or shining snow-flakes.

When flying in the wake of the ship in this irregular manner it was possible to catch and haul them inboard by flying lengths of strong thread from the halyards, the birds becoming so completely entangled by their wings that they were easily drawn in. Under these circumstances they gave vent to a guttural croaking sound, which seemed a most unsuitable note for such a dainty bird; this was followed by the regurgitation of a mucoid reddish-orange fluid, consisting of a mess of little shrimps, which was shot with some energy from the mouth and nostrils; one's feelings for the dove-like petrel became in consequence somewhat mixed. In one case, and strange to say, in one case only, this beautiful bird literally swarmed with lice. This particular individual was caught in the neighbourhood of the Balleny Islands; but it was quite an exceptional thing to find any bird or beast infested by these parasites in the Antarctic.

The food of the Snow Petrel consists almost entirely of *Euphausia*, a red shrimp-like crustacean, which abounds in the Southern waters. It lives there in countless numbers, and is thrown up by the breaking surf upon the edges of the icefloes, where the Snow Petrels hover with outspread wings to pick them up before the next wave comes to wash them off. Occasionally this diet is varied by a few small silvery fishes of the size of sprats, but the crustaceans form their staple diet.

The bird has but few enemies. McCormick's Skua may be seen occasionally chasing it; but not for its life, for the chase is over when the contents of the petrel's stomach have been surrendered. Apart from the Skua I believe it has no enemies. The Snow Petrel is a migrant within the limits of the ice-covered area, going northward with the sun in the autumn to frequent the northern limits of the ice belt, where it can obtain food in the open leads of water.

At our winter quarters in McMurdo Sound (78° S. lat.) we saw the last bird of the

* Starling = *Sturnus vulgaris.*

season on February 8th in 1902. In 1903 the open water was so far from our ship that we saw only a few stragglers during the whole summer, and none after the New Year. In 1904 we accompanied the bird to the north ourselves when we finally left McMurdo Sound on February 19th. We had it with us during the whole of our journey northward along the South Victoria Land coast, and off the Balleny Islands on March 2nd, when it appeared in flocks of a score or more together. All were uniform in size and of the larger type; not one of the smaller type was seen, but as they seemed to be in flocks and on the move, one could not consider this to be characteristic of the locality. Most of the birds that we saw after the middle of February in 1904 were moulting, and a shortage of primaries could be seen in the wings; but in 1902 we obtained moulting birds on January 11th, so that the moult evidently begins quite early in that month.

The flight of the Snow Petrel is exceedingly beautiful and dainty, and from the whiteness of its plumage it is very easily lost to sight on the snow-covered pack or ice-floe, appearing now for a second and now as suddenly disappearing, and there is something almost ghostly in the silent flight and sudden appearance and disappearance of this bird. Quite often one's attention is drawn to it by the flitting of its shadow on the snowy ground rather than by the bird itself. Though its flight is so beautiful, not only is its croaking guttural voice discordant, but its gait upon the snow is equally unbecoming. The legs are set widely apart, and the broad webbed feet are turned inwards, giving it precisely the same ungainly straddle-legged appearance that is familiar in the less elegant *Ossifraga gigantea.*

On March 4, 1904, we saw the last of its kind on our way to the North in S. lat. 67° and E. long. 154°. In November 1901, we had seen it in S. lat. 61° 46′, E. long. 140°. Sir James Ross reported it in S. lat. 61° 03′ S., 146° W., where he first met with it on December 18th, 1840.

Mr. Eagle Clarke reports that it was "by far the most numerous of the few species that remained for the entire winter at the South Orkneys" (60° 44′ S., 44° 50′ W.), where "in summer it frequented the high precipitous sea-cliffs which formed its breeding haunts, and where, during the nesting season, some 20,000 birds were estimated to be present on Laurie Island alone." (Ibis, January 1906.)

Even so far south as Cape Adare (S. lat. 71° 30′) the bird is reported by members of the 'Southern Cross' Expedition to have been occasionally seen late in the winter, on May 15th, and even on June 17th (Dr. Bowdler Sharpe on the 'Southern Cross' Collections). And although it has been taken in mid-winter so far North as the Falkland Islands, in all probability it was misled there by the wanderings of an over-extensive iceberg, and it may, notwithstanding this, be considered to have the most southern distribution of all known birds except the Emperor Penguin. Its nesting habits have been described not only by McCormick of the 'Erebus' and 'Terror' Expedition, but by Webster, of H.M.S. 'Chanticleer,' who found it on the South Shetlands; by the Germans in South Georgia, and more

recently by members of the 'Southern Cross' and Scottish Expeditions, both in the South Orkneys, Cockburn, and Franklin Islands, and at Cape Adare and Robertson Bay, so that here the shortest recapitulation will suffice. One egg only, bluish-white in colour, and measuring 2·2 ins. × 1·6 ins., is laid at the end of a burrow, from 2 to 6 feet in length, in the crevices of rocks, or may be "forty feet from the entrance of a cave." Here the hen sits for some weeks before she lays, and the place chosen may be either a few feet above sea level or as high as 1400 feet up a mountain side. Intruders are greeted with the customary petrel vomit, which consists of half-digested food, and is said to be ejected sometimes to a distance of eight feet.

"On November 20th," says Mr. Borchgrevink, "the birds were sitting on their nests at Cape Adare," and on December 10th he took their eggs in Robertson Bay, while on January 6th many years before, incubated eggs were taken on Cockburn Island by McCormick.

In the South Orkneys in 1903 the first eggs were taken by the Scottish Expedition on December 2nd. "They were then not quite fresh. By the 4th all the birds seemed to have laid." "In 1904 the first eggs were observed on November 25th, and young birds were found on January 28th, 1904" (Mossman). The young has been described by Mr. Eagle Clarke in the following terms: "About one-third grown, and captured on January 28th, 1904, it is clad in long fluffy down which almost conceals the feathers appearing on the wings and tail; the down is of a lavender grey tint on the back and chest, darker on the head, and dull ivory white on the abdomen"—the description in this case was taken from a specimen obtained in the South Orkney Islands by Dr. Pirie, Medical Officer and Geologist to the recent Scottish Expedition of 1902, and is figured in the 'Ibis,' for January, 1906. In the British Museum Catalogue the colour of the feet in the adult is given as "yellowish," a description rightly corrected by Dr. Sharpe in the Report on the 'Southern Cross' Collections, for the legs, feet, webs and nails are all of a dark bluish black, and although in flight the bird often buries them deeply in the under tail-coverts so that they are completely lost to view, yet they are also often carried exposed and quite conspicuous, contrasting markedly with the pure white feathers. It is true that the feathering of the bird is white, but there is in the quills, particularly of the wings and tail, and in the basal parts of nearly all the feathers quite a strong tinge of lemon yellow, which no doubt results from the ingestion of so much of the bright orange yellow pigment that characterises the crustaceans which form its staple diet. This pigment not only tinges the feathers, but colours the fat. The eyes, although apparently jet black at a short distance, are found when examined closely to have a very dark brown iris. The bird has been figured in the volume on Zoology of the 'Erebus and Terror' Expedition. Photographs of the bird upon its nest are to be seen in the 'Ibis,' January 1906 (facing p. 171), and also in the British Museum's publication on the Collections of the 'Southern Cross' (page 151).

## OSSIFRAGA GIGANTEA.

*The Giant Petrel or Nelly.*

*Procellaria gigantea*, Gmel., Syst. Nat., i. (1788), p. 563.
*Ossifraga gigantea*, Gigl., Faun. Vert. Oceano (1870), p. 48; Sharpe, Rep. 'South. Cross' Coll. (1902), p. 153, *ibique citata;* Eagle Clarke, Birds of S. Orkney Ids., Ibis, Jan. 1906, p. 172, pl. xi., fig. 2.

Material in the 'Discovery's' Collection.

No. 19, ♀ ad. sk. Dark variety with light head. Jan. 20, 1904. Cape Royds, McMurdo Sound.
No. 20, ♀ ad. sk. Dark variety with light head. Feb. 12, 1903. McMurdo Sound.
No. 21, ♂ ad. sk. Mottled grey variety. Feb. 23, 1903. McMurdo Sound.
No. 22, ♂ ad. sk. White variety. Jan. 9, 1902. Cape Adare.
No. 23, ♂ ad. sk. White variety. Jan. 9, 1902. Cape Adare.
No. 24, ♂ ad. sk. White variety. Jan. 9, 1902. Cape Adare.
No. 146, ♂ ad. sk. Pale grey variety. Iris, mottled yellowish white and grey. Nov. 22, 1901. Macquarie Island.
Nos. 161 and 162, adult skeletons. Both of dark variety. Ross Sea.

The colouring of the soft parts of this bird is as follows, and the description applies to all in the list except when specially signified :—

Bill, pale yellowish horn colour; the unfeathered skin-folds at the gape and junction of the bill and feathers, bluish grey.
Iris, brown, with yellowish radiating streaks.
Skin of eyelids, bluish grey.
Legs and toes, grey with pale yellowish tinge.
Web, fleshy grey.
Nails, blackish horn.

Material in the 'Morning's' Collection.

No. 29, ♀ ad. sk. Dark variety. 69° S. 178° E.
M.t., ♂ ad. sk. White variety. Jan. 8, 1902. Cape Adare.
M.v., adult skeleton.
M.w., ad. sk. March 1904. Auckland Islands. Collected by Dr. Souter, of the 'Terra Nova.'

Of the range and distribution of the Giant Petrel there is little to add to what has already been fully given in various publications, notably by Mr. Howard Saunders in the "Antarctic Manual."

"Its breeding and habits on Marion and Kerguelen Islands have been described by Moseley and others, and the bird probably nests on Heard Island; Webster found it on Deception Island, South Shetlands, from January to March; and as regards South Georgia, the eggs are laid in the beginning of November."

It wanders freely as far as 30° S. lat. to the North, and almost as far as any other living animal to the South, *i.e.*, to about 78° S. lat. In Mr. Eagle Clarke's account of the birds of the South Orkney Islands, it is stated to have been present in Scotia Bay all the year round, though less numerous during the winter months. Its nesting haunts on Laurie Island were confined to the north and east coasts, where upwards of 5000 birds are said to have been resident during the nesting season. The nests are described

as "great piles of small angular stones . . . . about two feet in diameter." The first eggs were here laid, very rarely more than one in a nest, on November 4th, and the average length of eighty eggs was 10·38 cm., and the breadth 6·57 cm. There is also in this account an interesting note which I quote below, upon the proportion of the white, dark, and intermediate phases. Plate XI., Fig. 2, in the 'Ibis' for January, 1906, shows an exceedingly happy photograph of the white phase of this bird with its nest and egg.

*Ossifraga* feeds mainly upon carrion, though its character is not above suspicion in the matter of attacking living animals. In one case, at any rate, the evidence of its having attacked man in the water is hardly open to doubt; I quote Mr. Howard Saunders, who writes: "Mr. Arthur G. Guillemard states that a sailor who was picked up had his arms badly lacerated in defending his head from the attacks of an 'albatross,' which may well have been this Giant Petrel." Mr. Eagle Clarke also, in his "Account of the Birds of Gough Island" ('Ibis,' April, 1905, p. 263), tells us that according to Mr. Comer, it carries off young Penguins to eat, and pulls Petrels from their burrows in the ground.

We constantly saw it feeding upon seals' blubber, dead penguins, and any other animal refuse that happened to lie in its way, but we ourselves never saw any living animal attacked; and although Mr. Eagle Clarke mentions "abundant remains of recently killed young penguins" in their rookeries in the South Orkneys, he says nothing in this case to prevent one from believing that the birds merely picked up the remains of what the Skuas had killed, or of birds that had succumbed to climatic causes.

The habit that this bird has, in common with most of the petrels, of disgorging semi-digested food when disturbed or annoyed is very commonly seen in putting it to flight after feeding. It is interesting to notice how small an amount of such ballast removed by vomiting seems to turn the scale, for it is quite insignificant when compared with what the stomach actually contains; yet the bird seems so utterly unable to run or to rise from the ice until relieved, that, no matter how closely it is pressed, it will come to a dead stop in order to disencumber itself by a number of voluntary efforts before making a serious effort to rise. The weight of the bird and the length of its wings necessitate a considerable run on the icefloe in any case before this can be effected. On one occasion the footmarks (fig. 43, p. 94) of a rising *Ossifraga*, seen on a drifting ice-floe from the ship, created quite a small sensation; from a distance they looked much like the footprints of some gigantic mammal.

The relative distribution of the various phases of this bird is a point to which a good deal of attention was paid throughout the course of our voyage. By making a rough estimate daily of the number of birds that we saw of this species, and notes as to their colouring, we came to the conclusion that the white form, although seen from time to time in the more temperate region of the Southern Oceans, is really very much more abundant, both absolutely and relatively, in the ice. And not only this, but that the abundance of the intermediate forms has also some relation to locality and climatic differences.

Fig. 43. Footprints of the Giant Petrel (*Ossifraga gigantea*).

Fig. 44. A Group of Black-browed Albatrosses (*Diomedea melanophrys*).

*To face p.* 94.

We first met with the Giant Petrel in 35° S. lat. on September 21st, when we were in the South Atlantic Ocean. It was in this case the darkest variety of all, with a lemon yellow bill, the variety that may with some truth be called black. Again, on October 22nd, in 45° S. lat., we saw the bird in the Southern Indian Ocean, and this example was also black. From that day onward we had one or two with us almost constantly between 45° S. lat., in 51° E., and the ice pack in 61° S. lat. and 143° E., and thence to New Zealand. At the Macquarie Islands we obtained one of the paler grey variety, the lightest in colour that we had seen in coming from the west; and a few days later, in passing up the western side of the Auckland Islands, we saw *Ossifraga* in very large numbers, almost all of which seemed to be somewhat small and grey instead of brownish black, as though they were perhaps the hen birds or the young of a nesting colony. On November 23rd, when we had passed to the north of the Macquarie Islands, we first saw the wholly white variety, and this was in lat. 55°, between 300 and 400 miles to the north of the ice pack we had then just left.

After leaving New Zealand we went due south to South Victoria Land, and after cruising eastward along the Great Ice Barrier to long. 152° W., we spent two years in McMurdo Sound, returning thence again to New Zealand by way of the Balleny and Auckland Islands. From New Zealand we made the homeward journey through the Magellan Straits and by the Falkland Islands, and throughout the whole of this part of our voyage to as far north as 33° S. in 20° W. lat. we were accompanied by *Ossifraga* in greater or lesser numbers.

The whole distance covered in the Southern Oceans was thus about 22,000 miles, and we were much struck by the way in which the several phases appeared and disappeared from time to time. In the open ocean, and in the more temperate regions throughout September and October, we saw only the largest and blackest birds, in good condition and with clear lemon yellow bills. On approaching the ocean islands of Macquarie and the Aucklands in November we came into a region frequented almost wholly by the smaller and greyer phase or variety, sometimes in great numbers, and these all apparently in full moult, but although we must have seen in all many hundreds, we had met with as yet one only that was wholly white, and that in the rather higher ranges of the temperate latitudes. Between New Zealand and the ice we again saw the grey birds moulting off Campbell Island on December 26th and 27th, and somewhat darker birds on December 29th. In the pack ice we saw one or two of the darker birds, but they became more numerous as we neared the coast at Cape Adare, and one might there constantly see two or three upon the floes running along with wide ungainly straddling legs, unable to rise after feeding on some dead Adélie Penguin.

On January 9th, when we came to Cape Adare, we were surprised to see a collection of Giant Petrels standing on the shore, about a dozen of which were wholly white. In all there must have been two or three dozen birds, the majority of which were black, dark grey and brown, though some had paler heads, and some had heads quite white, with darker bodies. They were less tame and more suspicious

of danger than we expected, and it was only with considerable difficulty that we could get close enough to shoot them as they ran with outspread wings and long strides to rise and go out to sea. We obtained three of the white birds and also one of the darkest brown. It was not easy to kill them on the shore, as they were all at the water's edge and took wing to the drifting ice floes, where they were soon completely out of reach. The white birds had the usual few dark feathers scattered here and there, but otherwise were wholly white. None of them, so far as we could ascertain, were nesting on this peninsula, nor did the 'Southern Cross' Expedition, in their stay upon the spot, see any Giant Petrels nesting. It is a curious fact, too, that a white Giant Petrel was, during their stay in 1900, considered a very great rarity by the members of the 'Southern Cross,' though they were stationed here for some thirteen months, covering part at least of two summer seasons. In connection with the frequency of the white phase of the Giant Petrel within the Antarctic Circle, as compared with its infrequency in the more temperate part of the Southern Oceans, I have put in a tabular form an estimate of the various phases, necessarily a very rough one, but formed by daily observation during the whole of our stay within the Antarctic Circle.

It is, of course, impossible, in a cruise on board ship, to say accurately what number of any particular species of bird has been seen each day, but it is possible to discriminate between such numbers as two, or half a dozen, or a score or more, and it is such a rough-and-ready estimate as this that I have attempted to make. It shows that whereas the white phase is a rarity in the sub-Antarctic region, it is by no means so rare in the region of the ice. In the sub-Antarctic region, moreover, *Ossifraga* is almost always of a uniform colour, either uniformly dark, blackish brown, or blackish grey, when viewed on the wing at a short distance, or else uniformly white. But within the circle one sees not only these unicolour phases, but a very considerable number of birds which vary between the white and dark. Some birds are dark all over, with white head and neck, and some are mottled grey, brown, and white.

It will be seen from this analysis, then, that in a voyage of 140 days, covering many thousands of miles of the sub-Antarctic ocean, only one White Giant Petrel was seen among several hundreds of the uniformly darker ones, giving a very small percentage, and also that the percentage of intermediate forms is almost as small, amounting to three or four in all, or less than a half per cent. Whereas if we compare this with the proportion of White to Dark and Intermediate birds in latitudes where ice conditions are persistent, we see that in a total of about a hundred birds observed during half as many days, in a voyage covering only about 4,000 miles, the percentage of intermediate birds rises to $23\frac{1}{3}$ per cent., and of white to as much as 30 per cent. Thus:—Between 33° S. and 66° 7′ S., we observed:—

| *Dark birds.* | *Intermediate.* | *White.* |
|---|---|---|
| At least 500. | 4. | 1. |

Whereas, between 66° 7′ S. and 78° S. we observed:—

| *Dark birds.* | *Intermediate.* | *White.* |
|---|---|---|
| About 60. | 14. | 18. |

I may quote here some remarks which have fallen from other observers upon the same point, and which, indeed, first led me to take special note of the facts:—Mr. Burn Murdoch, for example, in his book, "From Edinburgh to the Antarctic," says, speaking of Giant Petrels, "Some of them are partly white, and a few, of the same kind of bird, I believe, perhaps one in twenty, are pure white, all but one or two brown feathers." Thus giving the percentage proportion of white birds around Graham's Land, where the Dundee whalers were at work, as 5 per cent.

Mr. Eagle Clarke, on the other hand, in writing of the South Orkneys, says, "The proportion of birds in white plumage in the rookeries was not more, perhaps less, than 2 per cent.," going on, however, to say that the "colour of the birds ranged from very dark brown through all shades of chocolate, and from grey through light grey and mottled white to white."

Although 2 per cent. and 5 per cent. are a great deal smaller than the 30 per cent. which our observations show for the Victoria Quadrant, nevertheless, they uphold my main contention that the white form is very much more abundant in the ice-covered regions than farther north. For even 2 per cent. in the South Orkney Islands amounts to ten times as many as the highest percentage allowable on our observations in the temperate seas, where we saw but one white bird to, at the very least computation, five hundred dark ones. In South Victoria Land we saw a far smaller total number of Giant Petrels than were met with by either of the above-quoted observers; and I may also draw attention to the fact that the area in which our observations were chiefly made extended some 13 degrees (780 miles) farther south than Graham's Land, and no less than 17 degrees (over 1,000 miles) farther south than the South Orkneys. This very gradation in the percentage of white birds from 1 in 500 in the ice-free seas to 2 per cent. in the South Orkney Islands, then 5 per cent. in the ice off Graham's Land, and about 30 per cent. in South Victoria Land, so very much farther south, not only upholds but suggests that there are conditions in the ice-covered regions which are more attractive to the whiter variations than to the darker; but until white birds can be shown to interbreed and to exhibit some tendency to form nesting colonies apart from those of the darker birds, which at present is not the case, one can but surmise that in the above facts we are looking upon a very early step on the road to the formation of a distinct Antarctic species.*

Not only do such figures as the above lead one to believe this, but certain measurements of the bill and wing, taken first from a series of the darker phases and then from a series of the white phases, tend also to the same conclusion. Thus, in the 'Discovery' and 'Morning' collections we have nine examples, four of which are

* Since writing the above I have been reminded by Mr. Eagle Clarke that *data* obtained at the breeding grounds are of far greater value than those taken from birds that are merely wandering, and that the latter may be very misleading. While I agree with this objection, I have allowed my observations to stand for what they are worth, feeling that they may yet acquire some value, if breeding grounds are discovered farther south than the farthest that are at present known, namely, those in the South Orkneys and South Shetlands. And this appears to me to be possible, considering how small an area of the Antarctic has as yet been properly explored.—E. A. W.

white and five dark, and in the average of the bill and wing measurements given below the advantage in size is always slightly with the white variety.

| | Wing, cm. | Length of Nasal Tube, cm. | From Nasal Feathers to tip of Maxilla (by Callipers), cm. | Width (by Callipers) of Nasal Tube, cm. | Greatest breadth of side plate of Maxilla, cm. | Greatest length of side plate of Maxilla, cm. |
|---|---|---|---|---|---|---|
| WHITE BIRDS— | | | | | | |
| M.t, ♂ ... ... ... | 54·7 | 5·3 | 10·2 | 2·5 | 1·5 | 7·6 |
| D. 24, ♂ ... ... ... | 53·3 | 5·3 | 10·5 | 2·7 | 1·5 | 7·8 |
| D. 23, ♂ ... ... ... | 54·7 | 5·3 | 10·1 | 2·4 | 1·5 | 7·7 |
| D. 22, ♂ ... ... ... | 54·7 | 5·3 | 10·3 | 2·6 | 1·5 | 7·7 |
| Average ... ... ... | 54·35 | 5·3 | 10·275 | 2·55 | 1·5 | 7·7 |
| DARKER BIRDS— | | | | | | |
| M. No. 29, dark, ♀ ... ... | 53·3 | 4·5 | 9·3 | 2·4 | 1·3 | 7·4 |
| D. 20, white head, ♀ ... | 53·3 | 4·4 | 8·7 | 2·4 | 1·3 | 7·0 |
| D. 21, mottled grey, ♂ ... | 52·1 | 4·4 | 8·7 | 2·4 | 1·3 | 6·9 |
| D. 19, „ „ ♀ ... | 53·3 | 4·4 | 8·8 | 2·4 | 1·2 | 7·0 |
| M. w, dark, ♀ ... ... | 52·1 | 5·3 | 10·1 | 2·6 | 1·6 | 8·0 |
| Average ... ... ... | 52·82 | 4·6 | 9·12 | 2·44 | 1·34 | 7·26 |

This, one might think, could hardly have been accidental, but as three of the darker specimens were females, and all the white were males, the figures were not conclusive, and continuing the measurements to include birds in the collections of the British Museum, as the following table shows, the advantage in size is found to be not invariably with the white variety :—

| | Wing, cm. | Length of Nasal Tube, cm. | From Nasal Feathers to tip of Maxilla (by Callipers), cm. | Width (by Callipers) of Nasal Tube, cm. | Greatest breadth of side plate of Maxilla, cm. | Greatest length of side plate of Maxilla, cm. |
|---|---|---|---|---|---|---|
| WHITE BIRDS— | | | | | | |
| 93.12.4.2 Snares ... ... | 50·8 | 4·5 | 8·9 | 2·3 | 1·3 | 6·9 |
| 01.1.7.29 Campbell Islands | 53·4 | 5·4 | 10·0 | 2·6 | 1·4 | 7·7 |
| DARKER BIRDS— | | | | | | |
| 92.2.10.401 black... ... | 49·5 | 4·3 | 8·2 | 2·1 | 1·2 | 6·2 |
| 03.12.30.203 v. dark ♀ ... | 47·0 | 4·7 | 9·0 | 2·0 | 1·3 | 7·2 |
| 80.8.3.5 black ♂ ... ... | 51·5 | 5·3 | 9·8 | 2·6 | 1·4 | 7·9 |
| 80.11.18.635 v. dark ... | 52·1 | 5·0 | 10·2 | 2·5 | 1·4 | 8·1 |

My object is to point out that there must be some active reason for the preponderance of this pure white phase within the limits of the ice. Yet it is not easy to see how the facts can be brought within the range of the ordinary theories of animal colouration.

In the first place, it is fairly certain that the Giant Petrel has no need for protective assimilation to its surroundings in the ice, and yet this is possibly the first idea that occurs to one on learning that a white variety of a dark bird is very much more abundant within the Antarctic Circle than without. But it is quickly followed by a question respecting the enemies it hopes thereby to escape, and in this particular case the answer disposes at once of the protective assimilation theory, because the bird, whether black or white, has no enemies that are worthy of the name. In the water, no doubt, it might be surprised by a Killer Whale (*Orca gladiator*) or a Leopard Seal (*Stenorhinchus leptonyx*), but the position of any bird which can rapidly take wing from the surface of the water and never goes below is obviously not such as would require invisibility to protect it from such enemies as these.

Both beasts give ample warning of their approach by the noisy way in which they breathe. They are dangerous only to such birds and beasts as live habitually below the surface, where their approach is as sudden as it is silent and unannounced, and where little safety is to be found in anything but superior speed and more rapid powers of turning. On the ice floes the Giant Petrel, no matter what may be its colour, shows by its lack of nervous apprehension that it is not as a rule concerned with anything that may be there, except it be in the nature of something it can eat. We may, therefore, quite safely dispose of the assimilation theory so far as the protection of the bird from its enemies is concerned, and equally safely, I think, in so far as it is supposed to help the bird in obtaining food.

The Giant Petrel lives on any carrion that it is able to discover, and it can never be at a loss during the Antarctic summer for a plentiful supply of dead seals and penguins. I know not whether in the Macquarie and Auckland Islands and elsewhere it is also mainly a carrion feeder, but I can answer for this in the Antarctic. One has but to kill a seal on the shore in summer and visit the blubber refuse day by day to realise how quickly such food attracts the birds who are looking for it. None but the carrion feeders come to it; one sees no Albatross, no Snow, Antarctic, or Wilson's Petrel, though all must often scent it; but the Giant Petrel and the Skuas come in constantly increasing numbers.

It is a fine sight to watch a Giant Petrel, with a stretch of wing as extensive as that of an Albatross, beating up the wind in large circles along the shore in search of scraps that the tide has left there. His flight is as even as the flight of a *Diomedea*; for long one may watch in vain to see a stroke of the wings, but without an effort he now rises against the wind till almost at a standstill, and now with a wide majestic sweep turns out to sea, and so once more up into the wind again. It is a labour-

saving method of progression, beautiful enough to watch, but useful only in a land where time-saving methods are of little value.

If, then, invisibility is of no use to this bird either for protection or for procuring food, one is bound to go farther into the case and ask what other reasons can be given for this predominance of the white and lighter phases within the icy regions. Of the fact I am convinced, and I can see no explanation that can meet it on biological grounds. I believe, however, that it is a case which strongly upholds the physiological theories more than once advanced by Captain Barrett Hamilton and Mr. Bonhote recently, and by others long before, to account for the whiteness of Arctic and Alpine types.* These theories suggest that pigmentation is present most abundantly where the physiological vigour of an animal is at a high level, and that the deposition of pigment peripherally is associated with an active tissue metabolism, and is fundamentally a reserve or so-called "waste product," which can be called upon as a supply of energy to the body when occasion needs and under certain conditions. Also that economy in tissue metabolism tends to diminish the formation of pigment, and therefore that one may expect to find a diminution of pigment in any animal that is living at a disadvantage in respect to its surroundings. Under such disadvantages we may suppose that some of the Arctic and Alpine animals are living, *e.g.*, *Ossifraga* and *Pagodroma*, and to make up for this they have necessarily to economise their physiological forces, or, in other words, as far as possible to check the metabolism of their tissues. This leads, amongst other things, to the accumulation of fat and the reduction of pigmentation, and it is a notable thing, already widely recognised, that the accumulation of fat to an excessive degree and the absence of pigment in hair and feather, is frequently associated not only with Arctic and Alpine climatic conditions, but also with seasonal and age changes, all of which may in a sense be classed together as conditions having a depressing effect upon the metabolism of the various tissues, all, therefore, tending to check the production of so-called waste products, including pigment, all tending also to pallor and whiteness in the various tissues, including the hair, feathers, fat and skin of such animals as are exposed to them. That pigment granules can be removed from hair and feathers by the agency of phagocytes seems to be an established fact, and it accounts probably for a number of transitions from darker to paler tints, including those of old age and winter whitening, though the converse, by which white hairs or feathers convert to dark without a moult, is not established. And although, in speaking loosely of the "bleaching effect" of the short Antarctic summer, which far exceeds that of the preceding winter, upon the fur of *Lobodon* and *Leptonychotes*, and the feathers of *Megalestris*, *Aptenodytes* and *Pygoscelis*, the idea conveyed is probably that of some chemical change in the pigment granules, it is very possible that there may have been in the course of the summer months a definite withdrawal of these pigment granules preparatory to the growth of the new

* In a paper on Winter Whitening of Animals in the Proc. Roy. Irish Acad., Vol. XXIV., Sect. B., Part 4, by Captain Barrett Hamilton, and in "Knowledge," Dec., 1905, p. 293, in a paper on Colouration in Mammals and Birds, by Mr. Bonhote.

hair or feathers which are to replace those that contained them, and this view is to a slight extent upheld by a microscopic examination of fresh-grown and of so-called "bleached" hairs of *Lobodon*, for there appears to be not so much a change in the colour and character of the pigment granules, as a simple diminution in their number, though to make this point certain it would, of course, be necessary to repeat on the animals in question the observations made by Professor Metchnikoff on men and dogs (Proc. Roy. Soc., London, Vol. LXIX., p. 156, 1901).

But in *O. gigantea* we have to deal, not with a seasonal change of any kind, but with an increasing tendency in a pigmented species, which is becoming acclimatised to the Antarctic climate, to become white and unpigmented, and I consider that there is sufficient reason for discarding the usual explanations given in such cases, seeing that there is no apparent need for invisibility, and for considering whether the above physiological reasons may not be sufficient. The bird is normally an inhabitant of the temperate regions, and is apparently ranging more and more into the Southern Polar seas. In doing so it becomes migratory, and each year, probably, increases the extent of its winter range in point of numbers. Its tendency being towards acclimatisation for severer conditions, presumably some pressure is acting from the north to check its range in that direction. Every reserve of energy has to be called in to meet the extra tax upon its physiological forces, and the peripheral pigmentation, even though it may have had a purpose in other climates, is now recalled, while the tissue changes are *pari passu* depressed by the climatic condition, and fat, possibly as a consequence, begins to accumulate, serving a useful purpose by retaining the body heat. It is just possible, moreover, that the feathers themselves, when the spaces previously filled by pigment granules are occupied by air, are really a better non-conducting covering for the bird than they were before. If this be so, it is an additional factor in the rapid production of a white form typical of the Antarctic ice. It may be urged that this white form, if becoming acclimatised under less advantageous conditions than those under which the dark forms farther north exist, should show some definite deterioration, just as the most southern Skua, *M. maccormicki*, shows a definite deterioration in size from *M. antarctica*. Instead of this, it maintains its size, and even in some small points exceeds the measurements of the darker forms, suggesting that the formation of this new type or incipient species is not so much the result of pressure from the north as a proof of a tendency for the more robust of the race to spread in a new direction where the drawbacks may be outbalanced by better food, the absence of competition or enemies, or other and more subtle advantages at present beyond our ken.

## DAPTION CAPENSIS.

*The Cape Pigeon.*

*Procellaria capensis*, Linn., Syst. Nat. i. (1766), p. 213.

*Daption capensis*, Gould, B. Austr. vii. (1847), pl. 53 ; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 156, *ibique citata* ; Eagle Clarke, Birds of South Orkney Ids., Ibis, Jan. 1906, p. 174, pl. x., fig. 1.

Material in the 'Morning's' Collection.

(*a*) Ad. sk. No label.
(*b*) Ad. sk., ♀. Oct. 4, 1902. 42° S. 24° E.
(*c*) Ad. sk. Oct. 7, 1902.

Colouring of the soft parts :—

Bill, black ; the bare skin beneath the mandible, dusky red.
Iris, dark brown.
Legs and toes, black.
Webs, black between the toes, but white outside the third digit ; a frequent variety has white spots on the black web on each side of the central portion of each phalanx, with a deeper black surrounding each joint.
Claws, black.

*Daption capensis*, the well-known Cape Pigeon, made its first appearance during our voyage on September 18th, 1901 (31° S. 21° W.). It was then with us abundantly each day throughout our course by South Trinidad to Cape Town, where we arrived on October 3rd. We saw none while close in shore during our stay in Simon's Bay, but directly we left, on October 15th, we picked the bird up again and kept numbers with us throughout the whole of our voyage to New Zealand. Even while we were in the ice pack on November 16th and 17th we were accompanied by a few, and so on till November 28th, when we entered Lyttelton Harbour. On November 25th we were in sight of the west coast of the Auckland Islands and *Daption capensis* was around us in very great numbers. Yet in going south from New Zealand we saw hardly a sign of it; one only on December 29th, and a few on January 2nd, the day on which we sighted ice. Farther south than this we did not meet with it.

On our homeward voyage from the ice we first met it again on February 28th, 1904 (68° 30′ S. 173° E.), and we kept it with us past the Balleny Islands until March 6th. Then, strange to say, the species absolutely disappeared, and we saw no more on our way north to the Aucklands and New Zealand. What can be the explanation of this extraordinary difference between the enormous numbers we saw in the neighbourhood of the Auckland Islands during November and its complete absence in the latter end of March? It appears that there are far more extensive migratory movements in these ocean wanderers than we at present recognise. In November and December the Cape Pigeon should be breeding, as we now know from the observations made by the Scottish Expedition in the South Orkneys. There is

every probability that it breeds also in the Auckland Islands, on the precipitous western coast, and this would account for the numbers that we saw there in November. But do the young go southward in the autumn in a body? If not, why did we meet them just within the circle and lose them entirely farther north around their breeding haunts? And if in the autumn they do go south, one wonders for what purpose? Possibly our experience was exceptional. In the winter they are again farther to the north; we saw them between New Zealand and Cape Horn throughout the whole of June, 1904, between 50° and 60° S. lat., and in abundance. They were to be seen in enormous flocks in the Magellan Straits in July, and on the Atlantic side we carried them north with us, and saw the last on August 4th, 1904 (about 20° S. lat.).

No other petrel is so common in the Southern Oceans, and probably no other is so easily taken by thread entanglements. It feeds upon minute crustaceans, most of which appear to be coloured with the bright orange pigment that is so marked a feature in those animals. They are freely ejected in a mucoid orange-coloured mess when the bird is caught and handled, and the same objectionable habit is said to be indulged in when the birds are disturbed upon their nests, "six or even eight feet" being given as the distance to which it can be ejected, and "with great precision." I quote this from Mr. Eagle Clarke's most interesting account of the breeding and nesting habits of this bird. For very many years the nesting haunts of the Cape Pigeon have been so little known that no eggs had been taken before the Scottish Expedition found them in the South Orkneys. Here, we are told, about 20,000 birds resort for nesting purposes to Laurie Island alone. The whole account is so new and so interesting that I can but quote it word for word. (See "The Ibis," January, 1906, pp. 174–177.) "The eggs remained entirely unknown until December 2nd, 1903, when Dr. Pirie took the first specimens at the South Orkneys. The three nests from which eggs were then obtained were placed on open exposed ledges of cliffs on the west side of Uruguay Cove, Laurie Island, at heights from 20 to 100 feet above sea level. The nests were composed of a few small angular fragments of rock and a little earth, and contained single eggs which were quite fresh. . . . . Several were found frequently nesting near to each other on the same ledge, but isolated nests were not uncommon. . . . . On December 12th more eggs were procured . . . . and on January 13th, 1904, a fresh egg marked on December 2nd was found chipped, so that the period of incubation was not less than 42 days. . . . . Young birds were still in down on February 5th. . . . . The eggs vary from oval to elongate-ovate in form. . . . . The average of a large number of specimens is 62·35 × 43·11mm. . . . . In 1904 the first eggs were laid on December 3rd, or one day later than the previous year (Mossman). The numerous nests found were placed either on ledges of cliffs, or, though these were few, in hollows in the earth and among small stones on steep scree-slopes, and all were quite open. . . . . The chick in down, five days old, taken on January 18th, 1904, is slate-grey above, and paler and sooty on the under surface."

## HALOBÆNA CÆRULEA.

*The Blue Petrel.*

*Procellaria cœrulea*, Gmel., Syst. Nat., i. (1788), p. 560.

*Halobœna cœrulea*, Bp., Compt. Rend., xlii., 1856, p. 768; Salvin, Cat. B. Brit. Mus., xxv. (1896), p. 431, *ibique citata.*

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 131, ad. sk., ♀. 61° 46′ S. 140° 12′ E. Nov. 16, 1901. In pack ice.

Colouring of the soft parts:—

Bill, bluish black, the latericorn of the maxilla distinctly bluish.
Legs and toes, pale cobalt blue.
Webs, pink in the centre, grey borders at the free edges.
Claws, black.

*Halobœna cœrulea* is a bird which can easily be distinguished at sea from any *Prion* by the white termination to its tail. Flying constantly in company with the different species of *Prion*, in size and colouring much the same, it would be difficult to tell them apart were it not for this.

We first encountered it on October 24th, 1901 (45° S. 48° E.), when a very heavy sea was running, with a high wind and occasional storms of snow. Considerable numbers were flying round about the ship, and we kept them with us from that date onward as we went south; they were still with us in the denser ice-pack (62° S. 140° E.) on November 16th and 17th, 1901.

On our homeward voyage we had them with us again in the South Pacific between 135° W. long. and the Horn, and between 55° and 60° S. lat.; also in the South Atlantic, not far from the Falkland Islands.

These observations coincide with the accepted range of this bird, which is given as the Southern Seas, between lat. 40° S. and 60° S.

It has been known to breed in Kerguelen Island, where Mr. Eaton obtained their first eggs plentifully on October 23rd, laid in burrows made in the *Azorella* growing upon dry soft loam. A nestling, almost full fledged, was killed at the same place on February 9th. It has been obtained also at the Cape of Good Hope, and in the Pacific Ocean near Cape Horn; and we ourselves obtained a specimen, which was unfortunately shot to bits, in the pack ice of 62° S. lat. 140° E., two degrees farther south than the range given in the British Museum Catalogue.

## PRION VITTATUS.

*The Broad-billed Whale Bird.*

*Procellaria vittata*, Gmel., Syst. Nat. I. (1788), p. 560.

*Prion vittatus*, Lacép., Mém. Inst. (1801), p. 514; Salvin, Cat. B. Brit. Mus. XXV. (1896), p. 432, *ibique citata.*

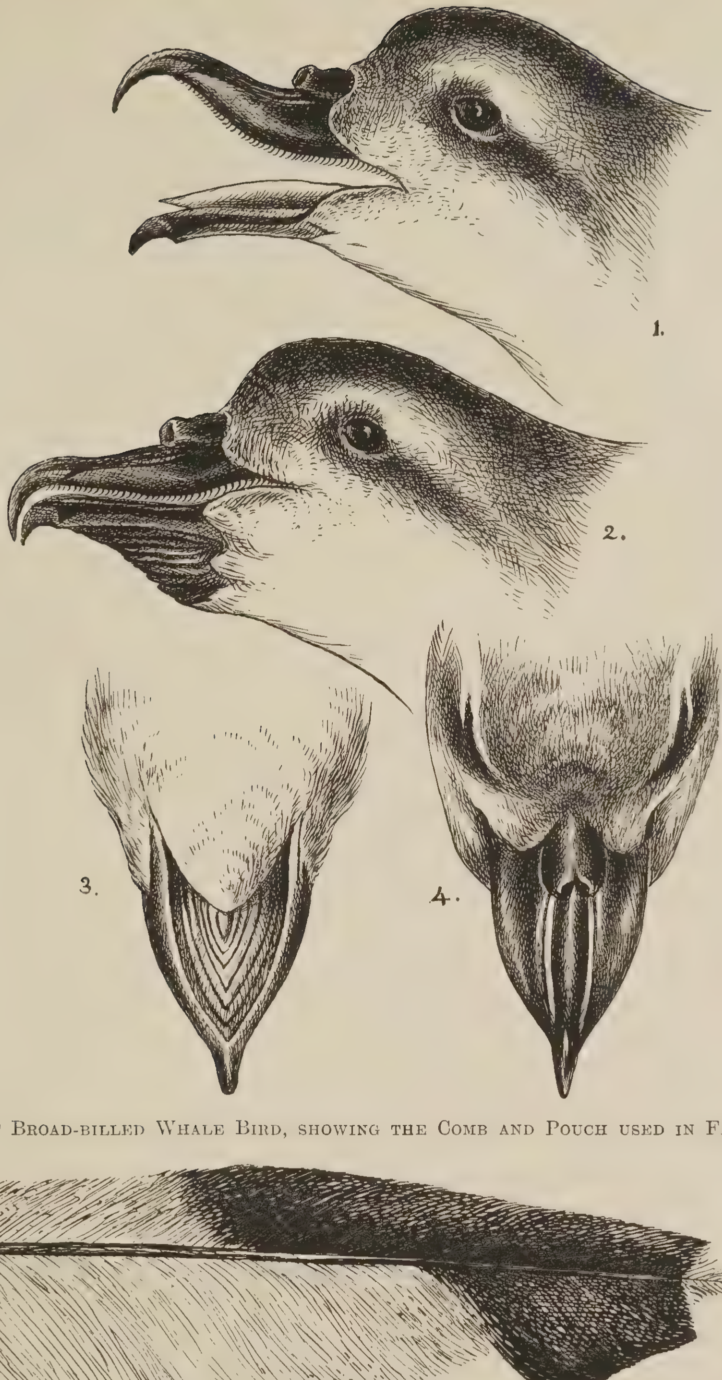



Fig. 45. Head of Broad-billed Whale Bird, showing the Comb and Pouch used in Feeding (*see* p. 105).

Fig. 46. Moulted Feathers of a Gull and Curlew, showing the value of pigmentation in resisting wear and tear (*see* p. 26).

*To face p.* 104.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 126, ad. sk., ♂. Oct. 22, 1901. At sea. 45° S. 40° 57′ E.

The colouring of the soft parts :—

Upper bill, pale bluish grey, shading into black at the base and on the nostrils, the central part of the culmen also black and the terminal part or point of the upper bill yellow.
Mandible, pale blue, with a black line along the centre of each side, and the tip black.
Iris, dark brown.
Legs and toes, pale blue.
Webs, flesh pink, with the free borders grey.
Nails, grey.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 1, ad. sk. Nov. 25, 1902.

THE various species of *Prion* are not readily distinguishable upon the wing, so that observations made on board ship and from a distance only are open to a very considerable amount of doubt. *Prion vittatus*, however, can occasionally be certified at close quarters by the enormous width of the upper bill. We obtained one or two specimens on the 'Discovery,' and were much interested to find that the floor of the mouth was very extensile, enabling it to take up a much larger quantity of water and small crustaceans than would otherwise be possible. Darwin, in his "Origin of Species," makes the following remark : "In the genus *Prion* the upper mandible alone is furnished with lamellæ, which are well developed and project beneath the margin ; so that the beak of this bird resembles in this respect the mouth of a whale." If the lower bill of a dried skin is examined more than this would hardly be noticed ; for the loose blue skin between the rami of the lower jaw will be found dry and folded to form a hard level floor to the mouth. But if the tip of the little finger is inserted into the mouth of a freshly killed specimen, it will be found that the neatly folded skin can be quite easily distended into the form of a bag, or sac, something like that of the pelican, which is obviously of use to a bird that has developed lamellæ on the upper bill which act like the baleen plates of a whale. The tongue is bright orange-pink in colour, smooth and fleshy, and of a suitable muscular character to assist in expelling the fluid from a mouthful of minute crustaceans and the water in which they were taken up. The accompanying figures were made from a fresh specimen ; in Fig. 45 (2), p. 104, the sac is lightly distended with a loose piece of cotton wool ; Fig. 45 (1), shows the sac in a state of normal contraction, and the neat small folds into which it is then thrown are shown in Fig. 45 (3).

The flight of the *Prion* petrels is wonderfully strong and untiring for such small birds. They are apparently always on the wing, and one rarely sees them resting on the water ; their flight is always very rapid, with quick changes, which show alternately the wholly white underparts and underwings, and the blue-grey backs with the darker V-shaped mark, which characterises this and allied forms of petrel.

## PRION BANKSI.

### *The Whale Bird.*

*Prion banksi*, Gould, Ann. and Mag. Nat. Hist., XIII. (1844), p. 366 ; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 159, *ibique citata* ; Eagle Clarke, Birds of S. Orkney Islands, Ibis, Jan., 1906, p. 177.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 130, ad. sk., ♀. Nov. 16, 1901. Ice pack. 61° 46′ S. 141° 12′ E.
No. 122, imm. sk.. March 18, 1904. Auckland Isles. Laurie Harbour.
No. 121, ad. sk., ♂. March 18, 1904. Auckland Isles. Laurie Harbour.

The colouring of the soft parts is as follows :—

Upper bill, pale cobalt blue, the nostrils and culmen being black, but the tip pale blue. No yellow nail.
Lower bill, pale blue, save for a narrow black line along the centre of each ramus, which begins at the base of the bill but stops short of the tip and spreads into a **T** at the junction of the terminal and the lateral portions of the beak.
Iris, dark brown.
Legs and toes, pale cobalt blue.
Webs, fleshy grey, almost pink, terminal border greyer.
Nails, blackish.

MATERIAL IN THE 'MORNING'S' COLLECTION.

M 1, ad. sk., ♂. Nov. 25, 1902. 67° S., 179° E.

WE found it impossible to distinguish with any certainty the various species of *Prion* upon the wing. It is, therefore, beside the point to give a more detailed account than the above of what we saw, and the following remarks apply only to the birds which we actually obtained. One was procured in the ice pack (61° 46′ S. 141° 12′ E.) in November. There was a considerable number around us at the time, but we were beset with ice too heavy for the easy management of a boat, and yet too loose to do without one, and it was exceedingly difficult, owing to the rapid drift of the ice, to pick up the birds we shot. We next obtained a decaying specimen of this petrel in a water-butt at one of the sealers' huts in the Macquarie Islands. In the Auckland Islands they had been breeding, and we obtained an adult which flew to a lantern on shore at night, and also a fledgling which could not yet fly, close to some burrows in a bank of tussac grass, where presumably it had been reared. We searched many burrows, but all were empty, and beyond this proof of its nesting there, we are uncertain as to whether we were examining the burrows of this or of some other species of petrel. The fledgling was taken on March 18th, 1904.

In September, 1901, we had hundreds of Whale birds in our wake (36° S. 5° W.), and we kept them with us throughout September, October, and November, in the South Atlantic and Southern Indian Oceans, even to the ice.

On several occasions soon after leaving Cape Town for New Zealand large flocks passed us, moving to the west and south-west, evidently on some business bent. It is noticeable that this bird, as seen from the ship, may in some lights completely

lose its blue colour, and appear to be pale brown, easily misleading one at first into the belief that two different petrels of the same size compose the flock.

Between New Zealand and the ice of Ross Sea they were abundant in December, and flew by night as well as by day, but we lost them on entering the pack.

On our return journey in February, 1904, we met them again in 71° S. 173° E., and kept them onward from that date to New Zealand, picking them up again in the South Pacific, and retaining them in our company, though not in large numbers, till we sighted South America. We did not see any in the Straits of Magellan, but again met them in the South Atlantic, and finally saw the last on July 30th in 30° S., 30° W.

On Shoe Island, one of the Auckland Islands, we found the ground covered with the bones of *Prion banksi*, and honeycombed with the burrows of some petrel. We could not satisfy ourselves as to which species they belonged, for the nesting season was over. The arch enemy of this bird is evidently the Quail Hawk, *Nesierax aucklandicus*, but probably numbers fall victims to the rapacious *Megalestris antarctica*, so abundantly common in that locality.

## PELECANOIDES URINATRIX.

*The Diving Petrel.*

*Procellaria urinatrix*, Gmel., Syst. Nat. i. (1788), p. 560.

*Pelecanoides urinatrix*, Lacép., Mém. l'Inst. iii. (1801), p. 517 ; Salvin, Cat. B. Brit. Mus. xxv. (1896), p. 437, *ibique citata.*

## PELECANOIDES EXSUL.

*Pelecanoides exsul*, Salvin, Cat. B. Brit. Mus. xxv. (1896), p. 438, *ibique citata.*

In mid-ocean one may see a small petrel, quite alone, flying fast and straight close over the wave-tops, until suddenly, like a stone, it disappears into the water. If the sea is particularly calm, it may be seen that its wings flap rapidly for three or four strokes, then follows a quick short sail, the bird seldom rising more than a foot or two from the surface of the water. Its flight seems to be hurried and in a straight line, coming to an abrupt termination as the bird dips. It is not easy to observe at sea, but its flight is so peculiar that it cannot well be mistaken for any other form of petrel.

.We saw it first in the middle of September, about 30° S. in the South Atlantic, and now and again in the Southern Indian Ocean, to 122° E. long., and as far South as 51°. A species of *Pelecanoides* was also seen in the Magellan Straits in July.

The recognised range of *Pelecanoides exsul* is over the Southern Indian Ocean from the Crozets to Kerguelen Island. It has been recorded from New Zealand and the Auckland Islands. It is possible that the bird we observed in the Magellan Straits was *P. urinatrix*, which is known to range over the Cape Horn Seas to the Falkland Islands, as well as the Australian and New Zealand Seas. The two species are, so far

as I know, indistinguishable on the wing, but the third, *P. garnoti*, of Western South America, is considerably larger than either of them. Probably the bird we saw in the open ocean was *Pelecanoides exsul*, and that in the Magellan Straits, *P. urinatrix*.

*Pelecanoides exsul* has been known to breed in Kerguelen Island, where the eggs were found on and after October 31st. Their burrows are said by Mr. Eaton to be as small as the holes of the Sand Martin (*Cotyle riparia*); they are made in dry banks and terminate in an enlarged chamber with no specially constructed nest.

## DIOMEDEA EXULANS.

### *The Wandering Albatross.*

*Diomedea exulans*, Linn. Syst. Nat. i. (1766), p. 214; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 160, *ibique citata*; Eagle Clarke, Birds of S. Orkney Islands, Ibis, Jan., 1906, p. 177.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 124, ad. sk., ♂. Sept. 22, 1901. At sea. 35° 10′ S. 13° 40′ W.

The colouring of the soft parts is as follows:—

Bill, whitish with a faint pink blush; the tip of both upper and lower bills being yellowish.
Iris, dark brown.
Eyelids, both upper and lower bright scarlet.
Legs and toes, greyish white.
Webs, pale greyish-white; when viewed by transmitted light, flesh pink.
Claws, whitish.

DIOMEDEA EXULANS, the Wandering Albatross, was first seen on September 18th, 1901 (31° S. 22° W.), an immature specimen in the brown plumage. From September 19th to the 23rd, several immature birds were seen. An immature specimen was seen again on September 19th, having a dark brown cap, upper parts brown, and a dusky collar round the neck. The same brown immature phase appeared again on September 20th, two or three together, and also an adult for the first time. On September 22nd an adult male was caught on a tin triangle; total length, 42 inches. The two first primaries on each side, new feathers, were just appearing from the sheath. In the stomach was an undigested Roman Catholic tract, with a portrait of Cardinal Vaughan.

On September 23rd, one adult and several brown immature birds.

September 27th to 30th, October 1st to 3rd, adult birds were seen, and on September 29th again an immature specimen.

The adult birds followed us close inland to Table Bay.

October 17th, two days out from Simon's Bay, several adults and immature.

October 18th to November 11th, one or more adults each day, and immature birds also.

From October 17th to November 7th, birds which were brown all over, but with a paler head.

On November 16th we were close outside the ice pack, and saw one adult. Also the following day one adult and one immature, and an adult on November 19th.

At the Macquarie Islands we saw both young and old on November 22nd. The species became more and more abundant as we neared the New Zealand coast, and at the end of November both young and old were exceptionally abundant.

After leaving New Zealand we saw many more on December 25th, both young and old being quite abundant each day onwards as we went south until January 2nd, when we came in sight of ice. This was the last that we saw of the bird, for it left us as soon as we entered the ice pack, and although it has been recorded off Ross's Great Ice Barrier, we ourselves did not see it farther south than 65° S.

On our return journey to New Zealand we saw every common form of Albatross except *Diomedea exulans* as soon as, or even before, we had left the immediate neighbourhood of ice, but although in December that bird had been abundant in the same seas, in March we saw very few indeed. In going north the first was seen on March 9th, 1904 (60° S. 177° E.)—a second-year's bird with a brown cap. March 10th and 11th each showed one bird. The 12th showed many more, two of which were mottled brown all over, a very young phase. On this day we saw five or six together, sometimes settled on the water. On March 14th nearly all that we saw were young and mottled, and we came close in to the Auckland Islands.

On June 10th we left New Zealand on our homeward voyage by way of the Magellan Straits. We saw several examples of *Diomedea exulans* between June 12th and 19th (chiefly third-year birds with brown caps). After this it absolutely disappeared until we had passed through the Magellan Straits and had entered the South Atlantic Ocean. Even then we reached the Falkland Islands without seeing a single example, and it was not until July 23rd (48° W. 46° S.) that the bird again appeared. On the 29th we saw one adult and one yearling, and an adult on July 31 (29° S. 27° W.), after which we saw no more.

When on the wing the feet are held folded together at full length under the tail, and, extending well beyond its longest feathers, give the impression of a markedly wedge-shaped tail with a white terminal border. This, of course, is not the case, for the tail is bordered by black at the extremity, and the appearance of white beyond the black is due to the whitish feet.

*Diomedea exulans* was by no means so devoid of shyness as some of the other albatrosses. *Diomedea regia* and *chionoptera* were the most shy of all, *exulans* occasionally found courage to come closer to our wake, sometimes quite close, but the most friendly and familiar of all were *D. melanophrys*, *Phœbetria fuliginosa*, and *Thalassogeron culminatus*.

*Diomedea exulans* is known to breed freely on Kerguelen Island, where a large number of nests are built on the grassy slopes 700 or 800 feet above the sea,

of straw and stubble plastered up with clay (Sir Joseph Hooker); they also breed upon the flat ground, according to Mr. Eaton (Phil. Trans. 168 (1879), p. 145).

We occasionally noticed the pink stains on the sides of the neck in this bird, which are remarked upon by Mr. Eaton.

## DIOMEDEA REGIA.

### *The Royal Albatross.*

*Diomedea regia*, Buller, Trans. N. Zeal. Inst. xxiii. (1891), p. 230; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 161, *ibique citata*.

## DIOMEDEA CHIONOPTERA.

### *The Snowy Albatross.*

*Diomedea chionoptera*, Salvin, Cat. B. Brit. Mus., xxv. (1896), p. 443.

THE former is the whiter of these, the two largest forms of albatross; it is an inhabitant mainly of the Southern Indian Ocean, but has been reported also from the South Atlantic.

As we did not succeed in obtaining specimens of either *D. chionoptera* or *D. regia*, it is not easy to speak confidently of the occurrence of these birds under one name or the other.

On certain occasions we obtained a view close enough to satisfy ourselves as to the identity of *D. chionoptera*, if complete whiteness of the whole wing except the primaries be a sufficient criterion to distinguish it from *D. regia*. And notwithstanding the doubt that must necessarily attach itself to observations unconfirmed by specimens, it may be worth while to record the following.

In the South Atlantic we saw a number of the larger albatrosses, but I believe that every one of them was to be referred to *D. exulans*. In the largest of all there was a narrow black tip to the tail, and this apparently is never seen in either *D. regia* or *D. chionoptera*.

In the Southern Indian Ocean, on the other hand, we constantly saw birds which appeared to have less black on the wings than seems consistent with *D. exulans*. We could not be certain, however, save on a few occasions. For example, on October 23rd, two adults with black primaries only came round the ship, and the tail in each case was wholly white. On October 24th another appeared, exactly answering to *chionoptera*, and after this we saw similar birds every two or three days, the last in 52° S. 110° E., before turning south towards the ice.

On March 11th, 1904 (56° S. 164° E.), we saw what we believed to be an example of *D. regia*, and, as we had an adult *D. exulans* in sight as well with which to compare it, probably in this case we were right. We saw others a little further north each day until we reached the Auckland Islands.

Between New Zealand and Cape Horn we saw neither, but in the South Atlantic we saw one of these larger forms quite close to the Falkland Islands, and another large and exceedingly white individual a little farther north. *D. regia* is a bird of the New Zealand seas, and has been taken in the Auckland Islands and New Zealand. *D. chionoptera,* on the other hand, frequents the Southern Indian Ocean, and has been taken on the Marion and Kerguelen Islands, as well as in the South Atlantic. Neither of these enormous birds was fond of approaching our ship at all closely. We had no chance of catching them as we caught *D. exulans, melanophrys,* and *Th. culminatus.* They sailed in wide sweeps, almost always at a distance from the ship.

Though the adults are so much alike, the downy nestlings of *D. regia* are said to be white, while those of *D. chionoptera* are brown, and in this respect the two species afford a somewhat parallel case to that of the two largest penguins, *Aptenodytes forsteri* and *patagonica,* which in the adult stage are far more closely alike than they are in the natal down. In the latter they are even more markedly different in colour than are the young of *D. regia* and *chionoptera.*

## DIOMEDEA MELANOPHRYS.

### *The Black-browed Albatross.*

*Diomedea melanophrys,* Boie in Temm., and Lang. d. Chartr., Pl. Col. v., pl. 456 (1828) ; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 161, *ibique citata.*

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 1, ad. sk., ♂, Dec. 29, 1901. With orange tip to the beak. 56° 54′ S. 170° 27′ E.
No. 2, ad. sk., ♂, Dec. 27, 1901. With orange tip to the beak. 54° 01′ S. 170° 47′ E.
No. 3, ad. sk., ♀, Dec. 29, 1901. With dusky blackish tip to the beak. 56° 54′ S. 170° 27′ E.
No. 4, ad. sk., ♀, Dec. 29, 1901. With orange tip to the beak. 56° 54′ S. 170° 27′ E.
No. 5, ad. sk., ♂, March 10, 1904. With orange tip to the beak. 58° S. 176° E.

The colouring of the soft parts is as follows :—

Bill, very variable, apparently with age, from a uniform dusky brownish hue in the younger birds to a uniform orange yellow in old adults. The tip always a deeper tone of the same colour as the bill. The most usual adult form is a clear lemon yellow throughout with a rich orange-red tip to the upper bill.
Iris, rich hazel brown.
Legs and toes, fleshy grey.
Webs, fleshy grey.
Claws, darker horn colour.
The feet and legs when seen at a distance appear to be of a fairly dark bluish grey, but if seen closer and by transmitted light, the colour becomes pink.

MATERIAL IN THE 'MORNING'S' COLLECTION.

No. 1, ad. sk., ♀, Dec. 1903. 56° S. 172° E.

*Diomedea melanophrys* was first seen on September 27th, 1901 (0° 38° S.): two young birds with dusky tips to lemon yellow bills. After this we saw it every

day, in varying numbers. It followed us close in shore to Table Bay, and appeared again at once as we put to sea. Throughout October it was more abundant than any other of the larger birds. Some were pale grey all over the head and neck, others had merely a broad or narrow collar of grey, incomplete below; the size also varied considerably, but all had the bill of *D. melanophrys*, dusky yellow, and always with a darker tip. We considered these grey-headed and grey-necked individuals, if the bill was broad, yellowish and darker-tipped, to be the young of *D. melanophrys.* There was no difficulty in distinguishing the grey-headed *D. melanophrys* from the grey-headed *Th. chlororhynchus* and *Th. culminatus*, since the colour of the bill in the two latter is much more clean cut and distinctly black and yellow than the dusky brownish or yellowish bill of the immature *D. melanophrys.*

Until October 19th we saw only immature birds, but on that day the white-headed adult, with lemon-yellow bill and orange tip, appeared. After this we saw each day for a while only adult birds, but on October 28th we had the following together: White-headed adults with lemon-yellow bill and bright-orange tip; white-headed birds with bright yellow bill and dusky tip, or with dull yellow bill and blackish tip; and grey-headed birds with dusky brownish bill and darker tip.

Throughout the first half of November, 1901, we saw one or other of these forms almost daily, and came to the conclusion that they were simply age changes, and that the grey-headed were the immature. We lost them all as we approached the ice, but had four with us of the yellow-billed phase the day after we left it. These birds had such deep yellow bills that the orange tip was hardly to be differentiated. They all had pure white heads. It will be convenient to arrange them thus :—

| | | |
|---|---|---|
| Phase 1. | White head and neck. | Orange-yellow bill, deep orange tip. |
| „ 2. | White head and neck. | Lemon-yellow bill, deep orange tip. |
| „ 3. | White head and neck. | Lemon-yellow bill, dusky brownish tip. |
| „ 4. | White head and neck. | Dull yellow bill, blackish tip. |
| „ 5. | Grey head and neck. | Dusky brownish bill, darker tip.* |

On November 20th we saw phase 3. On November 21st, phase 1. On November 22nd we saw phases 2 and 3, eight or ten birds at once, sometimes. We were then in sight of the Macquarie Islands, and the birds were here exceptionally plentiful. They also accompanied us on our way to New Zealand.

On leaving New Zealand for the south we found *D. melanophrys* exceedingly numerous on December 26th and 27th (S. lat. 53°). Most of them were of phase 1. One was small in size, though white-headed, and of phase 4, and a few were of phase 2. On December 28th they were more abundant than ever. Nearly all were of phase 2, and these, being the older and more plentiful, were the birds that we generally caught. A few were of phases 3 and 4. All had white heads (*see* fig. 44, p. 94).

* It is, of course, quite possible that these were really of a distinct species, but we failed in all our efforts to procure one, and I can here only give impressions received at the time from watching birds at some little distance.

The same remarks exactly apply to the next few days, until, on January 2nd, we sighted ice. On that morning we had five birds of phase 1 with us, and one of phase 3. After this we lost them entirely.

On our homeward voyage, from McMurdo Sound to the Auckland Islands, we first encountered them, six or eight together, and all of phase 2, on February 29, 1904 (67° 30′ S., 174° E.). We saw them in gradually increasing numbers, always of the same phase, from March 1st to March 14th. During this fortnight we saw probably over a hundred birds, and all were of phase 2, except one, which was of phase 4.

While anchored in Port Ross in the Auckland Islands we saw them out at sea, but they never came into the harbour. Between New Zealand and the Straits of Magellan, to our surprise, we saw not a single example of the bird. It appeared again, however, on the day that we sighted South America, and in the Straits we saw many hundreds sitting in large companies on the water. On the Atlantic side between Punta Arenas and the Falkland Islands we occasionally saw one or two of the typical adults, the last on July 27th, when *D. melanophrys* disappeared entirely, and its place was taken by a form we had before this hardly seen at all—a bird in every respect the same in shape and size as *D. melanophrys*, but with a grey ring always round the neck and the bill always quite black.*

*Diomedea melanophrys* wanders over all the southern oceans, and occasionally has made its appearance far in the North Atlantic. Of its seasonal migrations very little appears to be known, but even our own limited observations seem to show that they have definite movements at certain seasons. No mere weather changes can account for their congregation in the Straits in mid-winter, neither can accident only account for our having met only the fully adult form in the ice in autumn.

## THALASSOGERON CULMINATUS.

*The Grey-headed Albatross.*

*Diomedea culminatus*, Gould, Ann. & Mag. Nat. Hist. xii. (1844), p. 361.
*Thalassogeron culminatus*, Baird, Brew., and Ridgw., Water Birds N. Amer. ii. (1884), p. 358; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 162, *ibique citata*.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 6, ad. skin, ♀. Dec. 29, 1901. 56° 54′ S. 170° E.

* This bird appears to agree with the "Mollymawk" (*Thalassogeron sp. inc.*), mentioned by Mr. Eagle Clarke amongst the birds of Gough Island (*op. cit.*, p. 265). Those that we saw were evidently adult. They had the bill entirely black, and the head white, shading on the occiput, or sometimes on the hind neck, into grey which deepened round the sides of the neck to form a well-marked grey collar, incomplete upon the fore neck. The feet were rosy pink. In other respects, as in size, the bird closely resembled *D. melanophrys*. We saw it several times in March, from 55° S. lat. northwards as we came up to the Auckland Islands from Wilkes' Land. We saw nothing of it in the South Pacific; but in July we found it again in the South Atlantic, between 30° and 40° S. lat. as we came north from the Falkland Islands in 1904.

The colouring of the soft parts is as follows :—

Upper bill, black entirely, except for a band of pale yellow along the centre of the culmen from the edge of the feathers to the tip, where the pale yellow becomes orange pink.

Mandible, black along the cutting edge, otherwise rich ochreous yellow, with a narrow streak of orange red at the base, turning up to the angle of the mouth. Tip wholly black.

Iris, rich brown.

As in the case of *Thalassogeron chlororhynchus* this bird must be seen first at a moderate distance for recognition, since it is essential to make out the distribution of the yellow and black upon the bill. Having once done this it is not difficult to recognise it much farther away, though it requires care to avoid confusing it with young, dark-billed, grey-headed examples of *D. melanophrys.* There are, nevertheless, some very puzzling forms of albatross which are occasionally seen. For instance, on October 20th, 1901, we had a bird with the typical yellow culmen on a very dark beak, but the head and neck, instead of being wholly grey, were grey with a pure white crown, while the fore-neck and throat were also white, making the grey collar incomplete. Again on October 23rd, 1901, we saw a similar bird with the crown, cheeks and throat white, but with some grey around the eyes, and an incomplete grey collar round the upper neck. The depth of the grey on the head also varies in the apparently adult, sometimes approaching whiteness, indeed, the heads in a few were wholly white, and in others very dark grey. The blackness of the beak also varies, but in every case the yellow culmen is distinct, reaching from the orange tip of the bill to the nasal feathers.

We had *Th. culminatus* with us constantly in the last ten days of October and throughout the first half of November, 1901 (between 70° E. and 140° E., about 50° to 60° S.). It disappeared as we approached the ice, but joined us again the day we left it. We saw it off the Macquarie Islands, and it accompanied us thence on our way to New Zealand. In March, 1904, we met with it on our way north from the Antarctic (68° S., 157° E.) and kept it with us to the Auckland Islands. We saw it constantly between New Zealand and Cape Horn in June and in July, and although we did not see it in the Magellan Straits it appeared again occasionally on the Atlantic side. We saw no example further north than 45° S. in 45° W. Its recognised range covers the Southern Oceans, and it is known to go as far north as Central America on the Pacific side.

## THALASSOGERON CHLORORHYNCHUS.

### *The Yellow-billed Albatross.*

*Diomedea chlororhynchos*, Gm. Syst. Nat. i. (1788), p. 568.

*Thalassogeron chlororhynchus*, Ridgw., Man. N. Amer. Birds (1887), p. 53 ; Salvin, Cat. B. Brit. Mus. xxv. (1896), p. 451, *ibique citata.*

We first encountered *Thalassogeron chlororhynchus* in the South Atlantic Ocean on September 22, 1901 (35° S. 14° W.). It is quite recognisable on the wing by the character-

istic arrangement of black and yellow on the bill, which is distinct even at a considerable distance. It was with us from September 22nd to September 30th, 1901, and again quite close in shore off the coast of South Africa (False Bay) as well as over the Agulhas sandbank, but eastward of this, in the Southern Indian Ocean, its place was taken entirely by *Thalassogeron culminatus*, which we had not once observed in the South Atlantic. *Th. chlororhynchus* is known, however, to range over the South Atlantic and Southern Indian Oceans, and the Australian seas. That its range varies, however, with the season, as is apparently the case with so many Southern Ocean birds, seems evident from its complete absence during our voyage from the Cape to New Zealand in October and November.

No example was taken on the 'Discovery's' voyage.

## PHŒBETRIA FULIGINOSA.

*The Sooty Albatross.*

*Diomedea fuliginosa*, Gmel., Syst. Nat., i. (1788), p. 568.
*Phœbetria fuliginosa*, Reich. Av. Syst. Nat. Longip. (1852), p. V.; Sharpe, Rep. 'Southern Cross' Coll. (1902), p. 163, *ibique citata.*

## PHŒBETRIA CORNICOIDES.

*Phœbetria cornicoides*, Hutton, Ibis (1867), p. 192; Eagle Clarke, Birds of Gough I., Ibis (1905), p. 267.

MATERIAL IN THE 'DISCOVERY'S' COLLECTION.

No. 125, ad. sk., ♂. Oct. 20, 1901. At sea. 42° 40′ S. 33° 38′ E.

The colouring of the soft parts is as follows :—

Bill, entirely black, except for a narrow edging of livid blue along the cutting edges.
Iris, dark brown.
Bare skin of the chin beneath the mandible, dusky blue.
Legs and toes, flesh grey.
Webs, also flesh grey, but dull red by transmitted light.
Claws, quite pale grey.

THE Sooty Albatross is perhaps the most striking bird of all in the Southern Oceans, as it is the most sinister in expression and the best adapted by its dusky plumage, and its interested manner, to form the basis of sailors' legends and superstitions. On September 23, 1901 (36° S. 11° W.), we first saw it in our wake and thence onward until two days before we reached Cape Town, on October 3rd. On leaving, it was again two days before we picked it up. Then we had six or eight sailing round our ship, very inquisitive, but not at all inclined to feed in the ship's wake. They flew so close over our heads that we could see the expression of their eyes. We were flying meteorological kites at the time, and so interested were they in the messengers sent up, that they constantly fouled the lines. Throughout October they were abundantly with us, and we procured one male *Ph. cornicoides*, spanning 7ft. 4in.

from tip to tip of the wings. They arrived always in greater numbers towards evening, and on the evening of November 18th as many as sixteen were counted at one time. Both the light and the dark phases were generally abundant, though on November 12th, when we had eight together, they were all of the pale-backed variety.* The bird remained with us on November 16th and 17th as we entered the outskirts of the pack ice (62° S., 140° E.). It appears to shun the immediate neighbourhood of land, for on approaching and leaving the Macquarie Islands, as happened also when we approached and left Cape Town and New Zealand, we invariably lost the bird about two days out, and picked it up again at about the same distance when we left. Between New Zealand and the ice, at the latter end of December, we saw several each day. Some of these were almost white on the back and breast. On January 1st we saw one exceptionally white and another exceptionally dark. As we entered the ice on January 3rd they left us at the outskirts. We did not see this bird again until two years later when, on our voyage home, it was the first of the ocean birds to meet us. This occurred on February 22nd even farther south than Coulman Island, at 74° S. 170° E. It was one of the paler variety, probably *Ph. cornicoides*, which Mr. Eagle Clarke tells me is a more Southern form than *Ph. fuliginosa.* We saw one again on February 23rd, and three or four on February 27th, all of the paler variety. Eight or ten appeared on February 29th, when we still had icebergs round us, and *Pagodroma nivea*, the ice-indicator, in abundance. On March 4th we saw several very dark birds, and one at least almost white upon the back. Again both extremes appeared together on March 8th and 14th.

I have given for what they are worth the above occurrences of the two extremes of colour together. We did not appear to pass from an area of the one phase to an area of the other in any definite manner, but though there are innumerable intermediate individuals, the white and the black varieties are certainly very noticeable at sea, and it becomes a matter of interest to know what is their distribution in the breeding season.

There is no bird in the south with which it is possible to confuse these birds. The only other abundant large dark bird is *Ossifraga*, which, with its ungainly body and its enormous and pale yellow bill, in no way resembles the dark-billed, close-feathered *Phœbetria.* The latter, moreover, has an easy sailing flight, which is perhaps more perfect than that of any other albatross, and many of us considered it the most fascinating to watch of all the ocean birds on this account.

* How many of the birds we saw were really *Ph. cornicoides*, and how many *Ph. fuliginosa*, I cannot say. I am certain only concerning the specimen we captured, which Mr. Eagle Clarke has kindly identified for me from a coloured drawing of the head, made immediately after capture.

## A.

### Means and Extremes of Temperature at the 'Discovery's' Winter Quarters in Lat. 77° 50′ 50″ S. and Long. 166° 44′ 45″ E.

(From bi-hourly observations.)

| Date. | Mean. | Max. | Min. | Date. | Mean. | Max. | Min. |
|---|---|---|---|---|---|---|---|
| | Fahr. ° | Fahr. ° | Fahr. ° | | Fahr. ° | Fahr. ° | Fahr. ° |
| 1902. | | | | 1903. | | | |
| February ... ... | [1]15·8 | 29·2 | −0·8 | February ... ... | 11·2 | 32·2 | −10·0 |
| March ... ... | 7·7 | 27·5 | −13·2 | March ... ... ... | −0·8 | 25·5 | −21·0 |
| April ... ... ... | −7·1 | 19·5 | −31·6 | April ... ... ... | −16·9 | 5·2 | −43·0 |
| May ... ... ... | −12·8 | 19·0 | −39·5 | May ... ... ... | −16·1 | 9·2 | −52·2 |
| June ... ... ... | −16·0 | 13·0 | −47·0 | June ... ... ... | −13·9 | 17·0 | −45·0 |
| July ... ... ... | −8·5 | 15·0 | −38·0 | July ... ... ... | −21·1 | 12·0 | −55·2 |
| August ... ... | −16·6 | 6·0 | −50·5 | August... ... ... | −16·6 | 11·8 | −54·2 |
| September ... ... | −12·0 | 15·0 | −44·5 | September ... ... | −18·7 | 13·2 | −51·5 |
| October ... ... | −8·5 | 11·8 | −41·8 | October ... ... | −6·8 | 12·0 | −43·8 |
| November ... ... | 12·0 | 27·8 | 0·0 | November ... ... | [2]15·5 | 34·0 | −6·0 |
| December ... ... | 23·1 | 39·0 | 4·2 | December ... ... | [3]26·4 | 42·0 | 7·6 |
| 1903. | | | | 1904. | | | |
| January ... ... | 26·1 | 39·0 | 9·0 | January ... ... | [4]24·2 | 38·8 | 4·0 |
| Year ... ... | 0·27 | 39·0 | −50·5 | Year ... ... ... | 4·82 | 42·0 | −55·2 |
| | | | | 1904. | | | |
| | | | | February ... ... | [5]21·5 | 38·5 | 6·4 |

[1] Observations began on the 9th.

[2] After the 7th, observations were made from 8 a.m. to 10 p.m only. ... ... Mean of $\frac{8\text{ a.m.} + 8\text{ p.m.}}{2} = 15\cdot5°$.

[3] Observations generally made from 8 a.m. to 10 p.m. only ... ... ... ditto $= 26\cdot2°$.

[4] Observations made with varying frequency from eight to three times a day ... ditto $= 22\cdot2°$.

[5] Observations generally made at 8 a.m., Noon, 4 p.m., and 8 p.m., and discontinued after the 15th day. ditto $= 20\cdot3°$.

## B.

### Means and Extremes of Temperature at Cape Adare in Lat. 71° 18′ 0″ S., Long. 170° 9′ 30″ E.

(The mean for the day is the mean of observations made at 9 a.m. and 9 p.m.)

| Date. | Mean. | Max. | Min. |
|---|---|---|---|
| | Fahr. ° | Fahr. ° | Fahr. ° |
| 1899. | | | |
| February ... ... | *25·7 | 30·2 | 20·0 |
| March ... ... ... | 17·6 | 31·1 | −2·8 |
| April ... ... ... | 10·1 | 31·5 | −10·3 |
| May ... ... ... | −3·8 | 23·0 | −31·5 |
| June ... ... ... | −12·9 | 13·9 | −36·4 |
| July ... ... ... | −9·0 | 23·6 | −39·4 |
| August ... ... ... | −13·5 | 18·7 | −43·5 |
| September ... ... | −12·5 | 11·3 | −31·9 |
| October ... ... ... | −1·9 | 19·4 | −36·5 |
| November ... ... | 18·0 | 45·6 | −4·3 |
| December ... ... | 31·6 | 42·0 | 20·5 |
| 1900. | | | |
| January ... ... | 33·2 | 48·7 | 25·2 |
| Year ... ... . | †6·88 | 48·7 | −43·5 |

* Eight days only. † Omitting February, the mean for the 11 months is 5·17°.

# INDEX.

# BIRDS.

## Plate I.

The Emperor Penguin Rookery at Cape Crozier, from a sketch taken in September, looking eastward along the cliffs of Ross' Great Ice Barrier. In the foreground a bird is represented holding a living chicken on its feet, while another is about to take possession of a dead one; a third is sleeping in the prone position, and on the right a bird is represented sleeping in the more usual, upright, position.

Antarctic (Discovery) Exp. Birds, Plate I.

E. A. Wilson pinx.
Bale & Danielsson, Ltd. lith.

BIRDS.

PLATE II.

The head of an adult Emperor Penguin (*Aptenodytes forsteri*) in full plumage, life-size.

BIRDS.

PLATE III.

The heads of Emperor Penguins (*Aptenodytes forsteri*) at various ages. Figs. 1 and 2, the heads of chickens in down, at one week and one month respectively; figs. 3 and 4, of immature birds at five and six months respectively; figs. 5 and 6, of immature birds at seventeen months. All these are approximately one-third life-size. (*See* Aves, pp. 20 and 21.)


Antarctic (Discovery) Exp.

Birds, Plate III.

E. A. Wilson pinx
Bale & Danielsson, Ltd lith

## BIRDS.

### Plate IV.

Drawn from one of the frozen Emperor Penguin chickens, picked up on the ice at Cape Crozier. Although it stood without support as depicted, when frozen, it probably would be unable to do so at that age, in life. It was not more than a few days old, and the picture is life-size. This specimen can be recognised in the group of frozen Emperor Penguin chicks on page 30.

Antarctic (Discovery) Exp. Birds, Plate IV. E. A. Wilson pinx
Bale & Danielsson, Ltd. lith

BIRDS.

PLATE V.

The feet of young and adult Emperor Penguins. Fig. 2 shows the extent of web in the foot of the chick about a month old. Approximately life-size.

Antarctic (Discovery) Exp. Birds, Plate V.

E. A. Wilson [illegible]
Bale & Danielss[illegible]

## BIRDS.

### Plate VI.

Eggs of the Emperor Penguin, from the Cape Crozier Rookery. Fig. 1 represents the smallest of the series obtained, and fig. 2 one of the larger, with an unusual number of the characteristic little chalky nodules. Natural size.

Antarctic (Discovery) Exp.

BIRDS.

PLATE VII.

Eggs of the Emperor Penguin, from the Cape Crozier Rookery. Fig. 1 represents the largest of the series, and fig. 2 one slightly smaller, marked with an unusual streakiness on the surface, and but few of the little chalky nodules. Natural size.

Antarctic (Discovery) Exp.

Birds, Plate VI

E. A. Wilson pinx.
Bale & Danielsson, Ltd lith.

# BIRDS.

## PLATE VIII.

Four heads of the King Penguin (*Aptenodytes patagonica*). Fig. 1 is drawn from the head of a young bird in the down, taken at the Macquarie Islands in November; fig. 2 represents the head of a young bird upon the completion of the moult from the down, also taken in November; fig. 3, the head of an ordinary adult in full plumage; fig. 4, the head of an extraordinary adult in which the golden pigment has been developed to a very unusual extent. Approximately one-half natural size. (*See* Aves, pp. 35, 36.)


Antarctic (Discovery) Exp. Birds, Plate VIII.

E. A. Wilson pinx.
Bale & Danielsson, Ltd. lith.

# BIRDS.

## Plate IX.

The head of the Adélie Penguin (*Pygoscelis adeliæ*). Fig. 1, a day or two after emerging from the egg, with the angular pseudo egg-scale on the upper bill; fig. 2, about a fortnight old; fig. 3, shedding the downy plumage; and fig. 4, in the plumage of the first year, with white throat and blackish bill and eyelids; fig. 5 represents the head of a normal adult; and fig. 6, that of an isabelline variation, with the occipital crest raised and the eyes staring, as they appear in this species whenever it is angered or excited.

Antarctic (Discovery) Exp. Birds, Plate IX. E. A. Wilson pinx.
Bale & Danielsson Ltd lith.

## BIRDS.

### Plate X.

The feet of the Adélie Penguin (*Pygoscelis adeliæ*) at various ages. Figs. 1 and 2 are of corresponding age to fig. 1, Pl. IX.; fig. 3, of corresponding age to fig. 2, Pl. IX.; figs. 4 and 5, the normal foot of the adult; and fig. 6, an abnormal distribution of colour in the foot of an adult.


Antarctic (Discovery) Exp. Birds, Plate X.

E. A. Wilson pinx.
Bale & Danielsson, Ltd. lith.

# BIRDS.

## Plate XI.

Figs. 1 and 2, heads of the Royal Penguin (*Catarrhactes schlegeli*); fig. 3, head of the Great Penguin (*Eudyptes antipodum*).

Fig. 1 shows the gray-throated immature bird with as yet short golden superciliary plumes; fig. 2, the adult plumage with white chin and throat, and well-developed plumes. Both were taken in the Macquarie Islands, on November 22nd; fig. 3 shows the freshly-moulted plumage of *Eudyptes antipodum*, taken in the Auckland Islands on March 24th. (*See* pp. 35, 36 and 61.)

Antarctic (Discovery) Exp. Birds, Plate XI. E. A. Wilson
Bale & Danielsson

BIRDS.

Plate XII.

Heads of McCormick's Skua (*Megalestris maccormicki*) at various ages. Fig. 1, of nestling when first hatched, with the egg-scale still attached to the upper bill; fig. 2, nestling at about two weeks, showing the rapid growth of the bill; fig. 3, fledgling at about seven weeks, when the bird is just beginning to use its wings; fig. 4, young adult of the first year; fig. 5, adult at the end of summer, but before the moult.

Antarctic (Discovery) Exp.  Birds. Plate XI

Wilson del.
Bale & Danielsson

## BIRDS.

### PLATE XIII.

The feet and legs of McCormick's Skua (*Megalestris maccormicki*) at ages corresponding to the heads in Plate XII. Fig. 1, the leg of a nestling when first hatched; fig. 2, of a nestling from two to three weeks old; fig. 3, a stage of colouring reached at the shedding of the downy plumage; fig. 4, the leg of a normal adult; fig. 5, of an adult, abnormally piebald (*see* p. 68), in which the colouring of the immature bird has persisted.

Antarctic (Discovery) Exp. Birds, Plate XIII. E. A. Wilson pinx
Bale & Danielsson, Ltd lith

# III. ON SOME POINTS IN THE ANATOMY

OF THE

# EMPEROR AND ADÉLIE PENGUINS.

By W. P. Pycraft, A.L.S., F.Z.S.

(1 Plate and 8 text-figures.)

CONTENTS.



## I.—Introductory.

In the preparation of this report I have confined myself to a careful study of the nestlings and embryos, and to certain hitherto undescribed, or wrongly interpreted points concerning the pterylosis of the adults of the Emperor and Adélie Penguins; and this partly from choice and partly from necessity, since no complete adults in spirits formed a part of the collections brought home. Even had such specimens been preserved they could have added but little of importance to our knowledge of these remarkable birds. Thanks to the able monograph of Prof. M. Watson, which formed a part of Vol. VII. of the great series of volumes published on the results of the 'Challenger' expedition of 1872–76, we may be said to have a fairly complete knowledge of the general anatomy of the adult penguin, though much yet remains to be done from the systematist's point of view. Therein, at any rate, will be found a survey of the anatomy of nearly every genus, most of which holds good to-day, though in some particulars further research or better material have reversed conclusions therein expressed. In the memoirs of Prof. Menzbier (9), Schaunisland (14) and Studer (16), will be found much valuable matter with regard to the development of the penguin,

and this is especially the case with Prof. Menzbier's paper. So much having been done then, it has been my aim rather to extend our survey than to revise the work already mapped out.

## II.—Pterylosis of the Adult.

In their pterylosis the penguins differ from all other birds, even including the Struthious types; and this because of the uniformly even distribution of the feathers over the body. The only apterium is found extending in the form of a narrow space from the cloaca upwards to the middle of the abdomen. Even in the Struthious types, which approach nearest to this condition, *e.g.*, *Casuarius* and *Apteryx*, an *apterion trunci laterale* as well as an *apt. mesogastræi* is represented. It is impossible to distinguish remiges or coverts in the wing of the penguins, and the parapteron and hypopteron, as well as the *ala-spuria*, are all wanting also.

The rhamphotheca of the penguins is almost universally described as compound. Certainly it appears to be so in genera such as *Catarrhactes* and *Megadyptes*, inasmuch as a deep groove extends throughout nearly the whole length of the sheath upper jaw, dividing it into an apparent "rhinotheca" and "gnathotheca," recalling that of the Tubinares. In the remaining genera this groove is much less developed, while in the embryos of all the genera which I have had an opportunity of examining, this groove is either very feebly developed or altogether wanting. On examination of the beak sheath of any of these birds the groove in question will be found to terminate before reaching the tomium. Thus it would seem that the penguins are in this respect less primitive than has been supposed. From the slight indication of this groove in the embryo we must assume that the simulation of complexity in the beak-sheath of the adult is a secondarily acquired character. In the Emperor and Adélie Penguins this groove is not more marked than in, say, the curlew for example. The anterior nares in the penguins, except in the genus *Spheniscus*, close up soon after hatching; they would appear, however, to be functional for a short time, inasmuch as a bristle can be passed through to the posterior choanæ in very young nestlings. This peculiarity the penguins share in common with the Steganopodes, the Phæthontidæ and Fregatidæ only still maintaining functional nares, though extremely reduced.

It is a point of no little interest to remark that, while in the cormorants and gannets the osseous narial aperture has become entirely closed, and nearly so in *Phæthon* and *Pelecanus*, in the Sphenisci this aperture, in the dried skull, is of considerable size, extending, in fact, nearly the whole length of the beak. This, of course, refers to the adult skull. But in the nestling *Sula*, and in *Phæthon*, the narial aperture of the skull is as large as in the Sphenisci. It would thus seem that the closing of the osseous nares follows that of the external sheath only by slow degrees, and may not take place at all. Are we to regard the occlusion of the horny sheath of the external nares as due to adaptation to diving habits brought about by selection, and the later closing of the underlying osseous aperture—as in *Sula*—to the effects of

disuse, or to blastogenic variation? In the latter case it would seem that we must assume that the variation must have affected both the parts concerned at the same time—that both must have been included in the same germinal change—but that the outer horny beak-sheath proved more plastic, undergoing transformation at a quicker rate than the underlying osseous parts.

The podotheca is made up of a series of small more or less hexagonal scales, while the claws are of very considerable size, and show some variation in the matter of shape. In *Aptenodytes* the middle claw is always very large, and flattened dorso-ventrally, therein contrasting with the outer claw, which appears to be always somewhat compressed in shape; but the inner claw would seem to vary somewhat, in some specimens being decidedly compressed, and in others as markedly depressed. In *Pygoscelis*, also, the middle and inner claws are flattened, and the outer laterally compressed. In all the other genera, however, the claws are relatively somewhat smaller, and all agree in being laterally compressed.

In the extent of the webbing of the toes, the penguins present some interesting differences. Thus in *Aptenodytes* and *Pygoscelis* the interdigital webs do not extend more than halfway between the toes; in *A. forsteri*, indeed, the inner web is almost obsolete. In other genera, however, as in *Catarrhactes*, *Eudyptula*, and *Spheniscus*, the toes are fully webbed. In all cases the outer toe has a free fold of skin running along its outer side, just as in many other swimming birds, *e.g.*, *Anatidæ* and some *Rallidæ*. It is to be noticed that while in newly-hatched birds the toes can easily be spread and the webs examined, this is by no means the case with adult birds, wherein the toes apparently lose much of their power of lateral movement.

The oil gland is tufted. There is a thick underclothing of down feathers, and filo-plumes are present as usual.

### *The Structure of the Feathers.*

There is an almost universal tradition, religiously preserved not only by text-books of comparative anatomy, but even by works devoted entirely to Avian Morphology, to the effect that the feathers of the penguin are scale-like, and by some this supposed fact has been used as an example of one of the connecting links between birds and reptiles. The origin and spread of this myth is difficult to understand. Generally, doubtless, those who described these feathers as scale-like, and reptilian, merely wished to emphasise what they considered—certainly without looking at the structures in question—an accidental or convergent resemblance to scales. Anything more than this, any closer relationship, morphologically, a moment's reflection, having regard to the rest of the anatomy of this particular group, would show to be impossible.

How then can this misconception have arisen? What basis is there for its support? The origin of the tradition as to the scale-like character of the feathers of the penguin is now lost, but it had its rise, doubtless, in the fact that the feathers of these birds are

very close-fitting, stiff, and have flat, thick shafts. Further, the absence in the wing of definable primaries and secondaries, and the extremely small, thick-shafted feathers of the preaxial border of the wing, must have contributed much to the fostering of this myth. Founded on slovenly observation, it owes its perpetuation to the practice, unhappily not always avoidable, of accepting statements of earlier writers without reserve or verification.

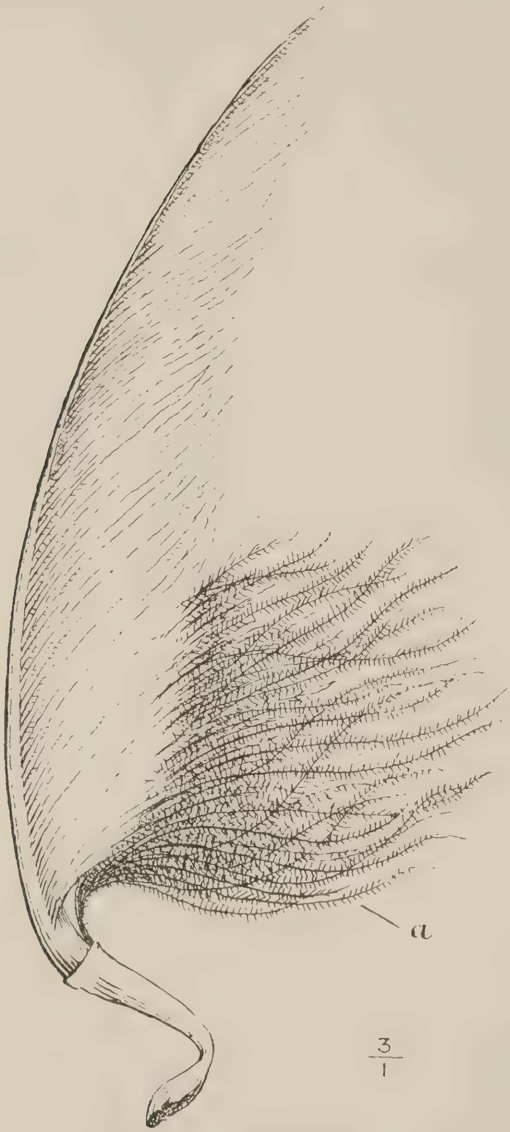


FIG. 1.—MOULTING CONTOUR FEATHER OF EMPEROR PENGUIN, *Aptenodytes forsteri*, SHOWING THE REMARKABLE CURVATURE OF THE CALAMUS, AND THE DOWNY AFTERSHAFT (*a*).

There can be no doubt, then, but that the feathers of the penguins have no more likeness to the scales of reptiles than have the feathers of other birds. As in the case of the flightless Struthious birds, the penguin's feathers are unquestionably degenerate, while in some respects they appear to have undergone some specialisation.

This specialisation is apparent in the structure of the shaft, which is curved in such a way that between the body and the outer surface of the feathers there is enclosed a wide space which is filled by down feathers. This forms an effective barrier against the intense cold in which these birds live—a barrier which is further supplemented by a thick layer of fat beneath the skin. The curvature of the shaft is peculiar. At the region where the calamus—which is extremely short, and dorso-ventrally depressed—leaves the skin, it turns sharply upwards, arches considerably, and then passes into the more gently curved rhachis (Fig. 1). This is broad and flat, fading on its ventral surface insensibly into the rami, instead of forming beneath these a more or less quadrangular beam as in more normal feathers. The aftershaft is peculiar in that it consists of a short, flat, flabelliform main axis supporting numerous long, downy rami.

The lower umbilicus of the calamus is not sharply defined. This is a point of some importance, inasmuch as it would seem to be due to the fact that before the calamus has actually completed its growth, the feather follicle at its base has begun to form the tips of the rami of the succeeding generation, the sheath enclosing which becomes fused with the rim of the umbilicus.

The degenerate features are found in the vane. Only a very narrow area on each side of the shaft presents to the naked eye the characteristic appearance of a continuous vane, this central portion being fringed on each side by a wide downy border, while the tip of the feather is formed largely by long, flattened rami devoid of radii, and produced by a splitting up of the free end of the rhachis to form a series of rods, arranged fanwise (fig. 2). By wear the length of these rami is greatly reduced, and thus the shape of the feather just before the moult differs somewhat considerably from that which it originally bore. Partly by this wearing away of the rami, and partly by the death of the pigment contained therein, the colour change noticeable between the feather of a moulting and a newly feathered bird is due.

*The Microscopic Structure of the rami and radii.*

That the vane of the contour feathers of the penguins represents a degenerate, degraded form of that characteristic of carinate birds which possess full powers of flight, is obvious. That is to say, the feathers of the penguin can in no sense be held to represent a primitive type of feather, but are unmistakably degenerate structures, bearing evidence to an earlier structural perfection identical with that which obtains to-day among birds that fly. In their degenerate characters they resemble the feathers of the flightless Palæognathæ (Ratitæ).

While among the feathers of birds that fly the rami of the remiges and rectrices grow shorter as they reach the tip of the shaft or main axis of the feather, so that none project beyond it, in the penguins the rami of what, possibly, answer to remiges show no such curtailment, but, on the contrary, are of great length, and give the shaft the appearance of breaking up distally into a fan-shaped series of rami (fig. 2), thereby agreeing with the contour feathers.

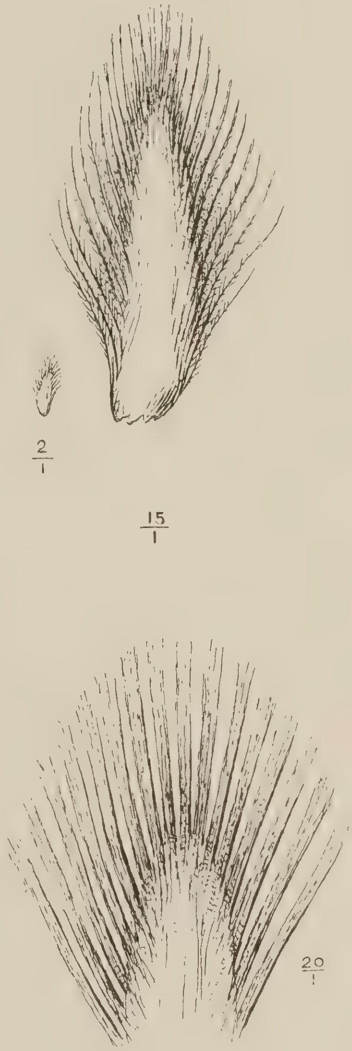



FIG. 2.—THREE FIGURES OF ONE OF THE SMALL FEATHERS FROM THE PRE-AXIAL BORDER OF THE WING, ENLARGED RESPECTIVELY 2, 15, AND 20 DIAMETERS. The most highly-magnified figure includes only the tip of the feather, and shows the fan-like termination of the rhachis.

The radii are less degenerate than in *Struthio*, for example, among the flightless birds; inasmuch as those of the distal series still possess their hooklets, though these are reduced both in number and size; they arise, however, as delicate, filamentous, curved processes from broad laminæ, twisted so as to lie with their flat surface upwards, as in functional remiges. The radii of the proximal

series, though more degenerate than those of the distal, overlapping series, still preserve their characteristic forward curvature, but they have become rod-shaped, losing the peculiar scroll-shaped curve which these proximal radii present in functional remiges. Finally, these radii grow fewer and shorter as the free end of the ramus is approached, leaving this, eventually, as a simple rod.

## III.—The Nestling Down.

The nestling penguin, on emerging from the egg, is but sparsely clad in down feathers which rather resemble, superficially, fine silky hair than feathers. This is quickly succeeded by a second growth of down feathers, longer and thicker; and this, later, is followed by the adult feathers or teleoptiles. This development of two successive down plumages is a feature which has hitherto escaped our notice in the life history of the penguin. Further, it has never been suspected to obtain, so far as I know, either in this or in any other group of birds, though, as will be shown presently, it occurs in a number of instances, and is likely to lead to some important modifications of our conceptions of plumages and their history.

The colour of the down in the Emperor, King, and Adélie Penguins has already been described by Dr. Wilson in his report. Consequently, I shall describe here only its structural features, and such other peculiarities as may be necessary.

### *The Nestling Down of the Adélie Penguin.*

I propose to describe the nestling down of this species first, because in this I have been able to trace the whole developmental history from the very young nestling to the adult bird, while in the case of other species some link in the chain has always been wanting. The down of the newly hatched nestling is short, and of a texture recalling velvet-pile. Microscopically, the rami are short, arise from a common base, and bear very short, straight, ribbon-shaped radii, which have but few fila, arranged, as usual, in pairs.

This down is rapidly succeeded by a long, dense, woolly covering, so dense that it is difficult to expose the skin. Except that it is shorter on the head and neck, it is of a uniform character throughout. If examined carefully, the earlier, shorter down tufts will be found adhering, here and there, to the tips of this second generation. The peculiar characters of this down may best be studied in birds which are just developing contour feathers. In such specimens it will be found that the tufts of these originally umbelliform pre-pennæ are in part attached to the rami of the main shaft of the contour feathers, and in part to the aftershaft thereof. *In situ* the tips of all the rami of each down tuft reach the same level, that is to say, the rami borne by the aftershaft extend to the level of those borne by the main shaft. To effect this, those rami which are supported by the aftershaft of the contour feather are connected therewith by a long ribbon-shaped stem, and this apparently on account of the fact that the after-shaft is so

much shorter than the rhachis of the definitive feather. This arrangement is somewhat remarkable and demands further explanation.


FIG. 3.—A DEVELOPING CONTOUR FEATHER OF *Pygoscelis adeliæ*, SHOWING THE MESOPTYLE DOWN-PLUMAGE BORNE IN PART BY THE MAIN SHAFT, AND IN PART BY THE AFTER-SHAFT (*a*).

In the first place, the fact that any of the rami of the pre-penna should be found in organic connection with those of the after-shaft of the contour feather is, so far as I know at present, elsewhere unknown. There can be no doubt, I think, but that the

neossoptiles represent distinct feather generations, and that therefore the pre-pennæ, as I have elsewhere (11) called those neossoptiles preceding contour feathers, are not, as some apparently hold, a part of—"agents in advance" of—the contour feathers which succeed them. Consequently, the fact that the bulk of the rami of the pre-pennæ in *Pygoscelis adeliæ* are directly attached to the tips of the rami of the after-shaft of the succeeding teleoptile is a somewhat remarkable fact, especially since in all other instances yet known the nestling-down, when attached to contour feathers, is attached to the rami of the main shaft. In the case now under discussion the rami of the pre-penna, which are borne by the main axis of the contour feather, are few in number and take no appreciable part in the formation of the pre-penna as a whole, which is composed of rami connected by means of the long ribbon-shaped stalk with the rami of the aftershaft, and forming the large tuft of woolly down such as is seen in Fig. 3. The significance of this relation to the aftershaft must be referred to again later.

Microscopically the rami of these "pre-pennæ" are of considerable length, and have short, ribbon-shaped spirally-twisted radii which bear only about four pairs of minute fila. The spiral twist acts as a kind of felting arrangement, whereby the downy covering is "knitted," as it were, into an almost homogeneous coat.

FIG. 4.—THE FIRST (NEOSSOPTYLE) AND SECOND (MESOPTYLE) DOWN FEATHERS OF *Aptenodytes forsteri*. M = MESOPTYLE.

### *The Nestling Down of the Emperor Penguin.*

This differs not only in colour but also in certain small structural details from that of the Adélie Penguin. The first down-plumage differs from that which follows, in that it is short, barely covers the body, and resembles silky hair more than feathers; that is to say, when superficially examined. Under the microscope each down feather is found to be made up of several rami, umbelliform in arrangement, and of moderate length, each ramus being produced into a long filament beyond the radii, which are short. The fila of these radii are much larger than in *Pygoscelis*. This first down-plumage is rapidly succeeded by similar umbelliform tufts of much greater length and volume. The rami are about twice as long as those which preceded them, but the radii are only, relatively, slightly longer, and bear from eight to ten pairs of fila. This generation of down feathers differs from the corresponding generation in *Pygoscelis*, firstly, in that the radii are straight instead of spirally twisted, so that the down is less "felted," and secondly, in that instead of being of a uniform character throughout, the rami of the down

of the hinder end of the body assume a harsh character, almost bristle-like: a character which may be due to adaptation to the peculiar environment in which these nestlings are reared. These two generations are shown in Fig. 4.

### *The Nestling Down of the King Penguin.*

Unfortunately no specimens of very young King Penguins appear to have been obtained as yet. Doubtless when examined they will be found to show the same succession of down-plumage as obtains in all the other genera.

To complete our knowledge of the nestlings of the King, and Emperor Penguins, very young examples of the former, and much older examples of the latter, than any which have yet been secured are necessary. But there seems to be little room for doubt that while the adults of these two species closely resemble one another, the nestlings thereof differ widely. In the Emperor Penguin the nestling has a black head and a greyish white body, while the young King Penguin is of a uniform dark brown.

The King Penguin retains its down-plumage for about six months, by which time the bird is nearly full grown. This down is remarkable for its great length—being about 3 inches long—and for its superficial resemblance to long and somewhat coarse hair. If examined when the contour feathers are just breaking through, it will be found that the rami are attached in part to the tips of the rami of the main shaft of the contour feather, and in part to those of the after shaft. Thus they differ from the down of *Pygoscelis*, wherein the contour feather bears but few of these rami. While the rami are of great length the radii are short. Though they bear about ten pairs of fila, these cannot easily be made out except under high magnification of the microscope.

In the nestling which formed the subject of this description pre-plumulæ and filoplumes also occurred, but I have not met with these in other genera. In this connection it must be recollected that this particular nestling was nearly twelve months old.

### *The Nestling Down of the Ringed Penguin.*

The nestling of the Ringed Penguin (*Pygoscelis antarctica*) is described by Mr. W. Eagle Clarke as differing remarkably from its congeners of the same age, in that, when newly hatched, it is clothed in a silky-white down, except the lower part of the abdomen, which is partially naked. But he does not say whether this naked area is really larger than the similar apterion which obtains in other species. Later this white down is succeeded by a thick, short, fur-like coat of grey.

### *The Nestling Down of the Gentoo Penguin.*

The newly-hatched chick of the Gentoo Penguin (*Pygoscelis papua*) appears to resemble the Adélie Penguin at the same age, being clothed in a fine silky down of

grey, deepening to black, or nearly black, on the head. This is succeeded, according to Mr. Eagle Clarke, by "a darker coat of down, to the tips of which the paler down of the first coat is attached for a time." It differs then from the Adélie Penguin only in that the down of the first coat is conspicuous on the tips of the second. This is not the case in any of the penguins which I examined. In these, consequently, the displaced down of the first crop is only to be made out by microscopic examination. But for this it would seem that the differences in texture and length between the down of the newly-hatched and full-grown chick were simply differences in the rate of growth of a normal downy covering.

### *The Composition and Sequences of the Neossoptiles.*

I have elsewhere shown that the nestling down of birds may be of two kinds, which may exist either singly or in combination. It would seem, so far as our present knowledge of the matter goes—which is not far—that as a rule the nestling is clothed in down feathers which are finally pushed out on the tips of the first generation of contour feathers, and these, in consequence, I have called pre-pennæ. In many cases, however, these pre-pennæ are intermixed with down-feathers, "pre-plumulæ," which are later succeeded by adult down-feathers. Only "pre-pennæ" appear to occur in the young of the Galli and Anseres, for example. It might have been expected that pre-plumulæ also would occur in the Anseres, inasmuch as these birds have a thick under-clothing of down feathers when adult, but these do not make their appearance till the end of the nestling stage.

The admixture of pre-pennæ and pre-plumulæ can be seen in the nestling of the Hoatzin (*Opisthocomus cristatus*) or in the young of the Accipitres, *e.g.*, *Falco tinnunculus*. There it will be found that the pre-pennæ are insignificant in size, and take but a small share in the covering of the body, while the pre-plumulæ are of great size, entirely superseding the pre-pennæ. It is not surprising, therefore, to find that in some species, *e.g.*, *Phalacrocorax* and *Colymbus*, the pre-pennæ have entirely disappeared and pre-plumulæ only remain. So far, the question of the down-plumages of nestling birds appears to involve only plain, straightforward issues—the plumage may consist of pre-pennæ or pre-plumulæ only, or a combination of both, then follow the teleoptiles.

As a matter of fact, however, this apparent simplicity is illusive. I have already shown that the owls (11) and the megapodes (12) furnish us with exceptions to this rule; inasmuch as in the former the pre-pennæ are not succeeded by normal contour feathers (except in the case of the Barn owl, which has hitherto been supposed to agree with all other owls), but by a type of plumage intermediate between down and contour feathers; while the megapodes pass through a downy stage while yet embryonic, and emerge with an intermediate type of plumage answering to that of the nestling owl. These facts now prove of much more importance than seemed to be the case at the time of their discovery. And this because of what has come to light during my investiga-

tions of the penguins herein described. The nestlings of these birds, as has already been pointed out (p. 6), before attaining the typical contour feathers, develop two distinct down plumages. Inasmuch as these neossoptiles are commonly split up by the succeeding contour feather, so that each of the terminal rami of the latter is surmounted by a ramus of the disintegrated down feather, it has been suggested that these down feathers are really a part of the actual contour feather.

Though Studer (20), Davies (4), Klee (9), and others have contributed some valuable observations on the development of nestling down and contour feathers, there is much work yet to be done on the embryonic history of the feather—much that as yet remains obscure, but is essential to a thorough grasp of this question. But there can be no doubt that the neossoptyles represent distinct feather generations. That later they become, in so many instances, disintegrated, so that the several rami of which they are composed are borne out on the tips of the rami of the succeeding definitive feather, is due to the fact that the growth of the definitive feather is begun before that of the neossoptile has finished, and consequently the bases of the rami of the first become welded on to the tips of those of the second, as will be made apparent presently. Let this be assumed as proved for the moment, and it will be seen that a new and important light is thrown not only on the sequences of the plumages of the penguins in particular, but of the nestling and later plumages of all birds. The penguins then develop two successive down plumages before assuming the normal definitive feathers. The point to be discovered is the significance of this sequence ; and this can best be done by a general and brief survey of what obtains in other groups.

Up till the present it has never been suspected that more than one generation of nestling down was ever developed,* though it has long been known that the succeeding generation of definitive feathers, in some species, presents a character intermediate between down and the contour feathers which eventually succeed them. Further, as I have already pointed out on more than one occasion, these down feathers present very different grades of perfection, such for example as may be seen in the umbelliform tufts of loose, woolly down of, say, an owl, the semi-plumous type of the Galli and Anseres, and the strongly pennaceous type of some Tinami. It has now become necessary to re-interpret the significance of these differences. It would seem, then, that the full sequence of plumages is represented (1) by neossoptyles, composed of (A) pre-pennæ, divisible into $\alpha$—*protoptyles* and $\beta$—mesoptyles; (B) pre-plumulæ, and (2) teleoptyles or definitive feathers.

In how many groups of birds these three plumages are represented I am at present unable to say, but I have undertaken, in conjunction with my friend Mr. J. L. Bonhote, a thorough examination of this problem. Consequently, I propose to do little more

* Since this was written, a paper has appeared ("Ibis," Jan. 1906) from the pen of Mr. W. Eagle Clarke, on the results of the Scottish National Antarctic Expedition. He therein briefly refers, without special comment, to the fact that in the young of the Gentoo Penguin, *Pygoscelis papua*, the down of the newly-hatched chick "soon gives place to a darker coat of down, to the tips of which the paler down of the first coat is attached for a time."

here than outline the facts which showed me the need of some such inquiry as that on which we have embarked.

These three plumages are developed, in anything like completeness, in but a few groups. But they can be followed in the owls for example, with one remarkable exception. In the Tawny, or Eagle Owl, for instance, it will be found that the nestling is at first clothed in long, woolly down; later, before quitting the nest, this is replaced by feathers, having a superficial resemblance to down, but which, when examined, are found to be intermediate in character between down feathers on the one hand and definitive feathers on the other. Down-like in their softness, they are yet feather-like in their colouration, and in that each feather is made up of a main shaft, rami, and radii, whereas the down feather is umbelliform. But while the head and trunk are thus clothed the quill and tail feathers are those of normal definitive feathers, and functional. This plumage is worn till the autumn, when the trunk feathers at least are replaced by new, and these of the typical adult structure. The exception referred to is found in the nestling barn owls. These birds have the down succeeded immediately by contour feathers, indistinguishable from those of the parent. To this we shall refer again presently.

This second generation of feathers we may call provisionally "mesoptyles." The penguin must certainly be regarded as having preserved what must be looked upon as a somewhat, perhaps very, ancient succession of plumages, but in these birds the "mesoptyles" have degenerated to mere down feathers. The megapodes, as is already known, shed their down feathers within the egg and emerge feather-clad. But these feathers, as I pointed out some time since (14, 15), differ conspicuously from the feathers which follow the next moult. In the light of my recent discovery the true interpretation of this plumage is clear—it is a mesoptyle dress. The differences between the "down" feathers of the Galli and Anseres now become capable of interpretation. They do not, as I imagined, represent a primitive type of down feathers homologous with the woolly, and so presumably degenerate, down of, say, the Alcidæ, but answer to "mesoptyles." The protoptyle or first generation of feathers would seem to be wanting in these birds, but I had the good fortune to discover small tufts of down adhering to the tips of the mesoptyles of a young *Chlœphaga rubidiceps*. Thus, then, we may assume that this first generation, since it has not yet been traced, has been lost in all the Galli, and probably all the Anseres save perhaps this species and one or two allied genera. It is significant that the only species in which it has so far turned up has a striped nestling plumage, which is undoubtedly a primitive sign.

Among the Galli, it is to be noted, the mesoptyles present varying degrees of perfection, in some, as in *Meleagris*, for example, a rhachis and aftershaft are fairly well developed, while in *Tetrao*, for example, the mesoptyles have become umbelliform. Similarly in the case of the Tinami. In *Calodromus*, for instance, the main axis is large and strong, and the rami set fairly close together, while the radii bear a close resemblance to those of the definitive feather. The after shaft is here also as long as the

main shaft. In other species, though a main shaft and hyporhachis are present, the radii are much more degenerate.

Some time since I drew attention to the fact (15) that though in the Cassowary and Emu the definitive feather bore an after shaft as long as the main shaft, in the nestling down the after shaft was barely traceable; while on the other hand the definitive feather of the Tinami possessed but a small or vestigial after shaft, while the "nestling down" had a hyporhachis as large as its main axis, thus reversing the order between adult and young in the two groups. It now appears probable that what have hitherto been regarded as the definitive feathers of the Cassowary and Emu are really to be looked upon as answering to the "mesoptyles" of the Tinami. That is to say, these birds, though they may have developed remiges of the normal definitive type, yet never acquired the feathers of this grade on the trunk. A parallel condition is seen among living birds to-day in the owls. The young Tawny Owl for many weeks is clothed, as to his trunk, in mesoptyles, but the remiges, which are functional, are those of the higher type of feathers. *Apteryx* certainly must be regarded as having lost the true nestling down; what is generally regarded as nestling down, and has been described as such by myself (15), represents a mesoptyle plumage. The nature of the nestling plumage of the remaining Struthious types will now require further study. To show how complex is this problem of nestling plumage it may be pointed out that in some birds, as, for example, *Phalacrocorax*, the first plumage is made up entirely of pre-plumulæ, while in other Steganopodes it is composed of pre-pennæ. In some of this group it may turn out that the plumage is composed of a mixture of both. The fact that in the penguins the rami of each mesoptyle are connected by means of a long ribbon-shaped stalk with the aftershaft of the definitive feather is one which must form the subject of further examination. At present no solution appears possible.

## IV.—The Moulting of the Adult Penguin.

The penguins appear to be peculiar in the method of their moulting, inasmuch as the feathers are not cast a few at a time, but over large areas the feathers of the moulting bird will be found to have actually lost all direct attachment to the body, and to stand out therefrom at right angles or thereabouts.

The moulting of the feathers has been described by more than one observer, but with especial care by the late Mr. A. D. Bartlett (2), and more recently by Mr. W. E. De Winton (5). The former, just seven and twenty years ago, gave a short account of the moulting of Humboldt's Penguin (*Spheniscus humboldti*). The feathers of the wing, he wrote, "came off like the skin of a serpent." But the feathers, he says, in speaking of the moulting of the trunk, "began to fall from all parts of the bird, not as birds usually moult, a few feathers at a time, but in large quantities." These old feathers were pushed off, he says, by the new ones, many of the old feathers being left

still attached to the new ones. This moult was exceedingly rapid, taking from first to last about ten days!

The observations of Mr. De Winton (5) were made on a King Penguin also in the gardens of the Zoological Society, and included two successive moults. The change here differed from that described by Bartlett in *Spheniscus*, inasmuch as he tells us that the feathers "became as withered leaves," lost all their lustre, and were assiduously removed by the bird, this operation being performed, not by pulling, but by pushing them with the beak from their attachment. They were not "peeled" off in masses as in *Spheniscus*.

During the second moult he discovered that each of the moulting feathers was attached by its base to the tip of that succeeding it. The new feathers he describes as "growing *into the bases of the old ones*, the thin sheaths attached to the bases of the feathers being occupied by the points of the new feathers." The effect of this peculiar attachment is to give the bird an extraordinarily bloated appearance, the old feathers standing out almost at right angles to the body.* Though the description and figures given by Mr. De Winton tally in the main with my observations made on the Emperor Penguins brought home by Dr. Wilson from the 'Discovery' Expedition, I find that in a few details they require amendment.

The skins of the moulting birds brought home by Dr. Wilson exactly agree with the description given by Mr. De Winton, thus showing that the peculiar method of moulting which he described was not due to the effects of confinement. In the skins in question the feathers are all erect and come away with the slightest touch. In some, however, as well as in a number of moulting feathers given me some time since by Mr. De Winton, the peculiar attachment of the old feather to the tip of the new, described by Mr. De Winton, is perfectly preserved. And an examination of these shows that the sheath which normally invests all growing feathers, instead of ending in a quill-like point, has become attached to the rim of the lower umbilicus of the old feather, which thus remains attached to the tip of the new until this has pushed its way some distance out of the skin and completed the growth of the enclosed rami. The sheath, by this time having lost its hold on the imprisoned rami, now easily comes off with the old feather.

## V.—The Syrinx of the Adult Emperor Penguin.

The syrinx of the Emperor Penguin, *Aptenodytes forsteri*, does not appear to have been previously described. As in the rest of the penguins it is tracheo-bronchial, but shows a tendency towards the bronchial type. The first bronchial semi-ring has the form of a gently arcuate rod, while the second and third are nearly straight. As will be seen in Fig. 5, the tracheal rings grow smaller immediately above the syrinx, and are also bent upon themselves; the tracheal rings from the antepenultimate onwards,

* *Cf.* Dr. Wilson's Report on Birds, p. 20.

however, have a somewhat greater circumference; and this is specially noticeable in the last. But the bronchial semi-rings 2–4 have a very wide span, so that the windpipe in this region reaches its greatest dorso-ventral width; from the fourth bronchial semi-ring backwards the circumference of the bronchus decreases rapidly. Only the first bronchial ring is complete—to its inner rim is attached the upper end of the *membrana tympaniformis.* The intrinsic muscles terminate in the middle of the antepenultimate ring, while the extrinsic muscle leaves the trachea at about the twentieth ring from the syrinx, counting from the last tracheal ring forwards. The trachea of this species shares with that of the remaining penguins the peculiarity of a median septum which extends the whole length of the trachea, from the syrinx forwards as far as the upper third of the tracheal tube. This septum is made up, in the adult, of a number of bony bars corresponding numerically to the number of the tracheal rings (Fig. 5); while that of the nestling differs from that of the adult only in being, like the rest of the trachea, entirely cartilaginous.

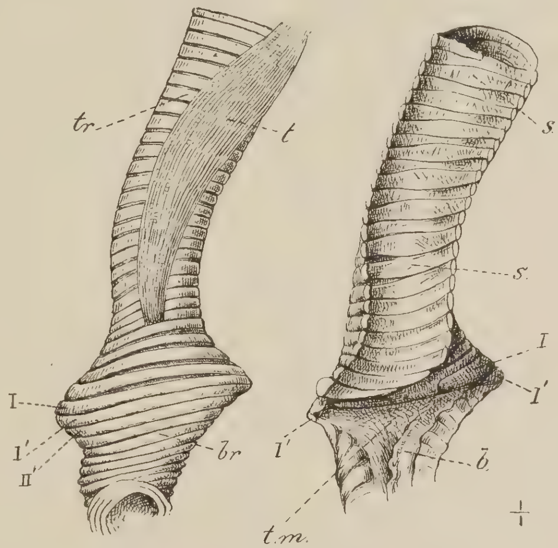



FIG. 5.—THE SYRINX OF AN ADULT EMPEROR PENGUIN, SIDE VIEW, AND IN SECTION TO SHOW THE TRACHEAL SEPTUM.
B = bronchidesimus; br. = bronchus; s. = septum; tr. = trachea; t. = trachealis muscle; tm. = tympanic membrane.
I. = 1st tracheal ring; I.[1] = 1st bronchial ring; II. = 2nd bronchial ring.

## VI.—Some Facts Concerning the Embryo and Nestlings.

I propose to deal here with a few facts concerning the rhamphotheca and the external nares, the palate, the developing wing and the tarso-metatarsus.

### *The Rhamphotheca.*

The shape of the beak in the embryo Emperor Penguin, at the time when the feather papillæ are just making their appearance, differs from that of the nestling, just as markedly as the beak of the latter differs from that of the adult.

In the embryo at the age just indicated the beak is relatively long, cylindrical, slightly swollen at the tip, and shows no trace of the egg-tooth. The anterior nares are open, but there is no sign of separate rhamphothecal plates, or of the groove which later appears in front of the nostrils.

In the newly-hatched nestling the culmen of the beak is arched, while near the tip is a small egg-tooth, which is apparently absorbed, since it is not detachable as in, say, young gallinaceous birds. Here, again, there is no trace of separate elements in the beak sheath, such as are met with in the petrels for instance, but there is a deep groove running from the nares forward, nearer the tomium than the culmen, but this does not

extend to the cutting edge of the beak. The anterior nares open, each by a small round hole near the middle of the inferior border of the beak; the rim of this aperture is slightly swollen.

In the newly-hatched Adélie Penguin (*Pygoscelis*) there is an ill-defined cere, which extends forwards and downwards on each side of the beak. The nostrils, however, do not pierce this cere, but open beneath it.

In the newly-hatched *Catarrhactes* there are at first but traces of a cere, and only a very slight groove in front of the nostril. This groove, however, later becomes much deepened and longer.

### *Osteological Characters.*

With regard to osteology, I may remark that since I have already dealt at considerable length elsewhere (16–17) with this subject, I have deemed it sufficient here to confine my remarks to such new points as have come to light during my examination of nestling skeletons of the Emperor and Adélie Penguins, and these, as I have already remarked, are confined to the following cranial characters.

### *The Palato-Pterygoid Articulation and Squamosal.*

The facts now to be described were gleaned from the skulls of nestlings of the Emperor Penguin (*Aptenodytes forsteri*) of about eight days old. Herein (Pl. fig. 7) the distal end of the pterygoid is deeply notched, and while the outer limb is rounded in shape and almost completely ossified, the inner is produced forward into a long, pointed, bony spike, which is embedded in the yet cartilaginous mesial border of the dorsal aspect of the palatine. The extremity of the palatine runs under this pterygoid spike (hemipterygoid), and is received into the notch just described. Seen from below the distal end of the pterygoid appears to be obliquely truncated, instead of notched, and this because the inner limb of the notch is applied to the dorsal aspect of the palatine. While the hinder end of the palatine is yet bounded by a rim of cartilage around its free end, the process of ossification has proceeded rather further in the pterygoid. But the main point to be noted is the fact that the palato-pterygoid articulation is by interlocking suture, and not by glenoid surfaces, and in this respect the skull resembles that of the more primitive group, the Palæognathæ (17). Later the pterygoid spike segments off from the main shaft and fuses with the palatine, and thereby the skull assumes its final neognathine form. But on the inner border of the distal end of the pterygoid I have discovered a little rounded patch of cartilage containing a bony nodule; from its position it is possible that this may be the last vestige of the reptilian epipterygoid rod. Later the ossification in the cartilage extends till the whole becomes blended with the pterygoid shaft.

Basipterygoid processes are represented only by vestiges.

The squamosal presents one or two interesting features deserving something more

than a passing notice. In the skull of the nestling just referred to, this bone is oblong in shape, broadest along its parietal border, and gently hollowed along three sides (Pl. fig. 6). Its posterior border articulates with the lateral occipital, which is yet chiefly cartilaginous, while the anterior border is embedded in the cartilaginous alisphenoid. In the skull of a nearly full-grown bird in the Museum collection, obtained during Ross' Antarctic Expedition of 1839–43, the separate elements of the skull are still free, though ossification is complete—a fact of no little interest and some importance—and here (Pl. fig. 8) the squamosal has retained the same general shape as in the younger specimen. But it has assumed, externally, a shallow trough shape, the hollow forming the major portion of the "temporal fossa," and it has at the same time thrown out a thickened phlange of bone immediately above the squamosal articulation for the quadrate; this phlange forms the superior limb of a >-shaped bony protuberance which ultimately passes into the "paroccipital" process. The parietal border is produced forwards to form a sharp angle, whose apex is separated from the frontal only by a narrow wedge formed by the parietal.

The significance of this can only be appreciated by a comparison of the squamoso-parietal relations in other species (Pl. figs. 1–8). Unfortunately, at present, I cannot make this comparison as comprehensive as could be wished; but nevertheless one or two interesting facts have come to light out of the material to hand.

In the skull of a full-grown *Pygoscelis papua*, in which no fusion of the roofing bones of the skull has taken place, the squamosal is roughly Γ-shaped, the superior edge of the backwardly directed limb articulating with a long, oblique, and downwardly directed edge provided by the parietal (Pl. fig. 5). But between the anterior angle of the superior border of the squamosal and the frontal there is interposed a broad parietal border. *Catarrhactes* agrees with *Pygoscelis* in this respect, but in the former genus the squamosal is oblong with a slightly hollowed *posterior* border (Pl. fig. 1).

*Pygoscelis adeliæ*, it is to be noted, resembles *Catarrhactes* rather than its ally *P. papua*, in so far as this region of the skull is concerned, since, as in *Catarrhactes*, the alisphenoidal border of the parietal is sharply truncated, and this is a fact which we would hardly have expected.

That there is some underlying principle involved in the variations met with in this region of the skull is highly probable. At present we can only hazard a guess as to what this principle may be; but it is not unlikely that we shall be near the truth in assuming that in the skull of *Pygoscelis* we have a more primitive type than in *Aptenodytes* or, indeed, of any other penguins except perhaps *Eudyptula*, which has not yet been examined. The evidence for this is based upon the characters now under discussion, which, adopting Dr. Chalmers Mitchell's method of analysis, we may regard as a metacentre, while the apocentricities arising therefrom are multiradial.

I have fixed, rightly or wrongly, on *Pygoscelis papua* as the point of departure of this metacentre, for the following reasons. In this skull the squamosal articulates with the parietal by means of a long oblique suture, sloping from behind

forwards and downwards, thus the articular surface for the squamosal looks distinctly backwards (caudad) and downwards, while the parietal border cephalad of the squamosal forms therewith a sharp angle. Now, taking the Class Aves as a whole, as specialisation proceeds, that is to say, as the cranial cavity increases, the orientation of the roofing bones changes; so that the supra-occipital, parietal, and frontal regions, instead of lying one in front of the other, come more and more to turn upon themselves so as to lie one upon the other, while the parietal becomes narrower antero-posteriorly, but increases in length laterally. At the same time the squamosal shifts forwards, passing the parietal angle described above, and approaching nearer and nearer to the frontal. In *Aptenodytes*, where the frontal is almost reached, we have one of the initial stages in this changed relationship of the squamosal. In the majority of the higher *Carinatæ*, indeed, the squamosal actually comes into juxtaposition with a large portion of the frontal bone. A further feature of this specialisation is seen in the fact that in the more primitive skulls the squamosal is entirely superficial, while in the more highly specialised it has come to absorb the underlying tissue of the parietal and so to take a direct part in the protection of the brain. Apparently only in *Aptenodytes*, among the penguins, does the squamosal pierce the cranial wall in this way, when, partly by a reduction of the upper end of the prootic, and partly by the absorption of the parietal a portion of its inner surface appears within the cerebral cavity.

We might here observe that in the relation of the squamosal to the cranium Birds resemble the Mammalia rather than Reptilia, a fact which is due to the relatively enormous size of the brain in either case. Among Reptiles the Birds agree much more closely with the Rhynchocephalia than with any other group of living Reptiles. The relations of the palatal bones and the presence of a quadrato-jugal arch afford convincing evidence of this. Thus, in *Sphenodon*, the quadrato-jugal articulates, as in birds, with the inferior extremity of the quadrate, immediately above the lower jaw, while in lizards and snakes the rod-like jugal bar extends forwards from the base of the squamosal immediately above the head of the quadrate to join the post-orbital process.

### *The Wing of the Embryo.*

The wing of the embryo penguin, if examined at the time when the first traces of bone are beginning to form around the cartilaginous skeleton, will be found to differ remarkably from that of the adult; and entirely confirms the contention that the paddle of the modern penguin has been derived from a functional flying wing. And this not only because at this early stage the wing agrees, even in detail, with that of typical Carinatæ at the same stage, as may be seen in fig. 9, but also because it agrees in all essentials with that of the adult flying bird more closely than at any other later stage of development. But the transformation to the paddle-shaped organ peculiar to the penguins takes place with great rapidity after the

appearance of the first bone cells ; so much so, that all the essential characters of the adult paddle are present, in the case of the Emperor Penguin, for example, long before the beak has acquired its typical shape, and while the feathers are as yet but papillæ (Pl. fig. 10).

Let us compare the wing of an embryo *Pygoscelis adeliæ* on the one hand with that of an adult of the same species, and on the other with that of a somewhat later embryo of *Aptenodytes forsteri*. In the wing of the younger embryo it will be noticed that ossification is just beginning to take place in the bones of the forearm, and that these are more or less dumb-bell shaped, and circular in section. The carpal elements are as yet distinct, the radiale being wedge-shaped, instead of cuboid, as in the adult, and the ulnare almost cuboid, instead of triangular, as in the adult ; while the distal elements of the carpus are three in number. Carpale 1 is small, spherical, and not very sharply differentiated from the embryonic tissue, and this is also true of carpale 3. Carpale 2 forms a large semilunar plate closely applied to the base of its metacarpal. The metacarpalia are all distinct, Mc. I being short and placed at an angle with Mc. II, which is long, cylindrical, and expanded at each end, while Mc. III is rod-like and extends distad beyond Mc. II. The phalanges are long, and also cylindrical. The terminal phalanx of Digit II, it is to be noted, is constricted round its middle, and has its free end expanded in such a way as to suggest an earlier phylogenetic stage when this digit bore an ungual phalanx. The phalanx of Digit III is remarkable for its great length, and forms a slender cylindrical rod, slightly bowed, and extending as far as the middle of the terminal phalanx of Digit III. From the somewhat hastate shape of its free end we may infer that this digit was armed with a claw up to within comparatively recent times. Though as development proceeds this phalanx changes shape, and loses something in length, it remains throughout life unique among birds for its great size.

The figure of this wing of *Pygoscelis* (Pl. fig. 9), should now be compared with that of embryo Emperor Penguin (*Aptenodytes forsteri*) (Pl. fig. 10). Though apparently the bird from which this wing was taken was but little older than that of the *Pygoscelis adeliæ* just described, it has assumed all the principal features of the adult wing, and this fact will become the more obvious in comparison with Pl. figs. 10–11. In the preparation from which this drawing was made the primary cartilaginous skeleton can still be traced, though in places the absorption of the cartilage by the growing bone cells has begun. The rod-like form of the long bones has now become transformed into broad bars, the carpus has assumed its adult form, but the pollex is yet free. Though Digit II bears an ungual phalanx, this appears to be wanting in Digit III ; possibly, however, a slightly later stage would show that the cartilage segments to form this, and that it remains distinct for some time.

Between this wing and that of the adult there is less difference. The most striking feature indeed is the disappearance of the pollex, which can now only be traced with difficulty, since it has fused completely with the metacarpal of Digit II., leaving at most but a single groove or a few perforations along the line of fusion. Digit II. loses its

ungual phalanx, while Digit III. is slightly shortened and terminates in a point. The humerus in the adult, like the rest of the wing, has undergone great flattening, as well as marked changes in its extremities. Its distal end has become twisted on itself, so that the radial and ulnar condyles lie one above the other, instead of side by side, and, further, have become reduced so as to form confluent facets, while the olecranon process is now produced backwards into a prominent, triangular spur, bearing two deep grooves for the lodgment of sesamoids of large size. The proximal end has also undergone considerable changes, the most marked of which are the increased size of the glenoid surface of the head and the great size of the fossa trochanterica. The skeleton of this limb is non-pneumatic. The result of these modifications has been to permit the several segments of the wing to be extended so as to form a straight-jointed rod, but one allowing of but little motion between the joints. In the normal wing the hand can be straightened out upon the forearm, but the latter is always, from the nature of its articulations, bent upon the humerus. But then, of course, in the one case the wing is used as a paddle, in the other for the purposes of flight, though the paddle of to-day, there can be no doubt, was earlier used as a wing.

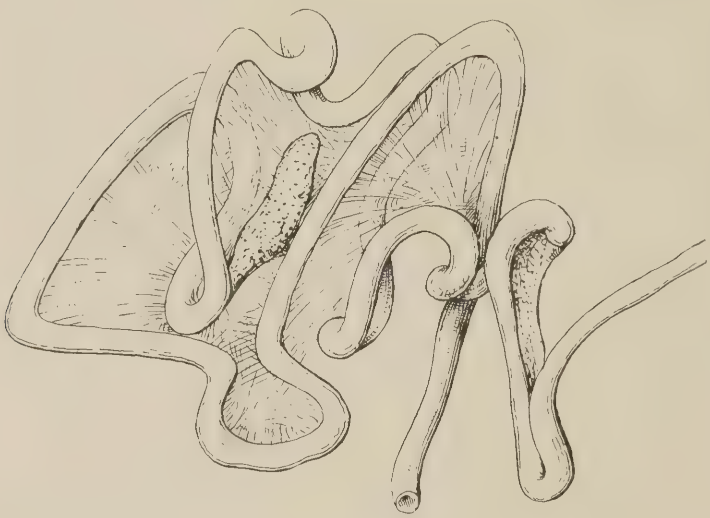


FIG. 6.—THE DUODENAL LOOP OF A NESTLING EMPEROR PENGUIN.

*The Tarsal and Metatarsal Bones.*

In the embryo of the Emperor Penguin, to which the wing just described belonged, the tarsus is wholly cartilaginous, but the proximal row, though showing no separate elements, is yet free and is applied in the form of a cartilaginous pad to the bones of the metatarsals II.–IV. The metatarsals are also all free, and, it is important to remark, have the form of perfectly cylindrical shafts, thus showing that the peculiarly broad and semi-distinct metatarsals of the adult have not assumed this shape by a secondary flattening process, as some have suggested, but that the tarso-metatarsus, on the contrary, actually presents a primitive stage.

## VII.—The Intestinal Tract.

Dr. P. Chalmers Mitchell (12) has described and figured the intestinal tract of *Catarrhactes*, *Spheniscus demersus*, and *Aptenodytes patagonica*, his preparations being made from adult specimens. I am enabled here to add descriptions of this tract in the Emperor Penguin, *A. forsteri*, and the Adélie Penguin, *Pygoscelis adeliæ*, but unfortu-

nately my material has been restricted to nestlings only. Nevertheless it seems to me that the peculiarities in the tracts in question are too marked to be materially affected by age. Dr. Chalmers Mitchell has shown that *Catarrhactes*, *Spheniscus* and *Aptenodytes* agree rather closely one with another in the great length of Meckel's tract, and in the form of the supra-duodenal loop, which is simple and in all of considerable length—relatively longest in *Spheniscus* and shortest in *Eudyptes*. *Spheniscus* and *Catarrhactes* alike have the duodenal loop of great length and thrown into a series of minor loops, wherein they differ from Aptenodytes, in which the duodenal loop is simple, of great length, and coiled upon itself.

It would now appear, from what follows, that while among the penguins there is to be found a common general resemblance in the convolutions of this tract, there is, at the same time, a greater range of differences between the species of a genus than might have been supposed; how great this range may be is a matter for further research. Thus, while in the King Penguin, *A. patagonica*, the duodenal loop is a simple closed loop coiled upon itself; in the Emperor, *A. forsteri*, it forms what may best be described perhaps as a series of interlocking U-shaped loops (fig. 6); while in the Adélie Penguin, *Pygoscelis adeliæ*, the loop is, as in the King Penguin, simple and coiled, but the coils, however, are much more voluminous, as may be seen in fig. 7. The Adélie and Emperor Penguins show a further common resemblance in that in both species the supraduodenal loop is folded back upon itself instead of forming a single loop as in the other genera already described: while the tract in *Pygoscelis* is still further remarkable in that the loops in Meckel's tract appear to be fewer in number than in any other penguin yet examined, though it must be remembered that the condition here described is that of a nestling. The number of loops may increase with age.

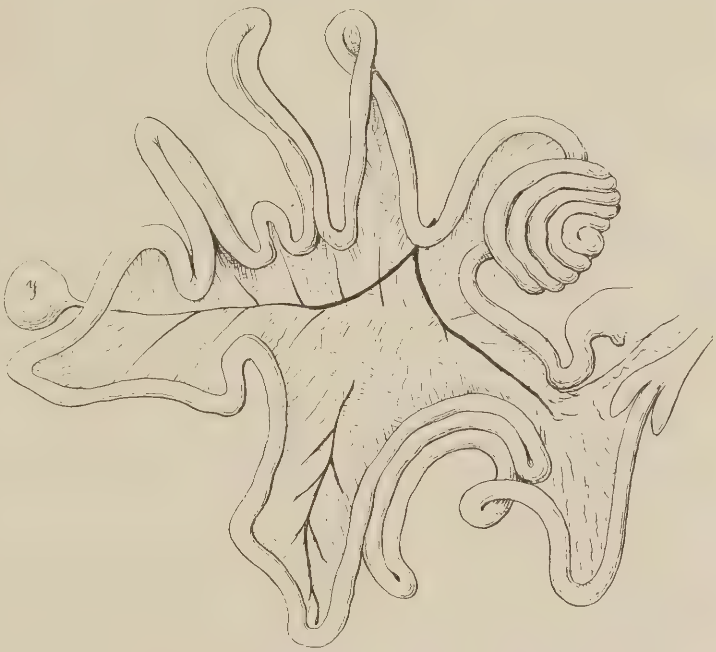


FIG. 7.—THE INTESTINAL TRACT OF A NESTLING *Pygoscelis adeliæ*. Note the coiled duodenal loop.

Meckel's diverticulum in the young Emperor Penguin is situated, not as usual at or near the end of the apex of a loop, but at the bottom of the valley between two adjacent loops (fig. 8).

The very remarkable difference displayed by the intestinal tracts of the King and

Emperor Penguins is the more striking, because the food of the two birds does not appear to differ in any conspicuous degree, while externally the two species bear a very close resemblance when adult, though this is not the case with the nestlings (pp. 8–9).

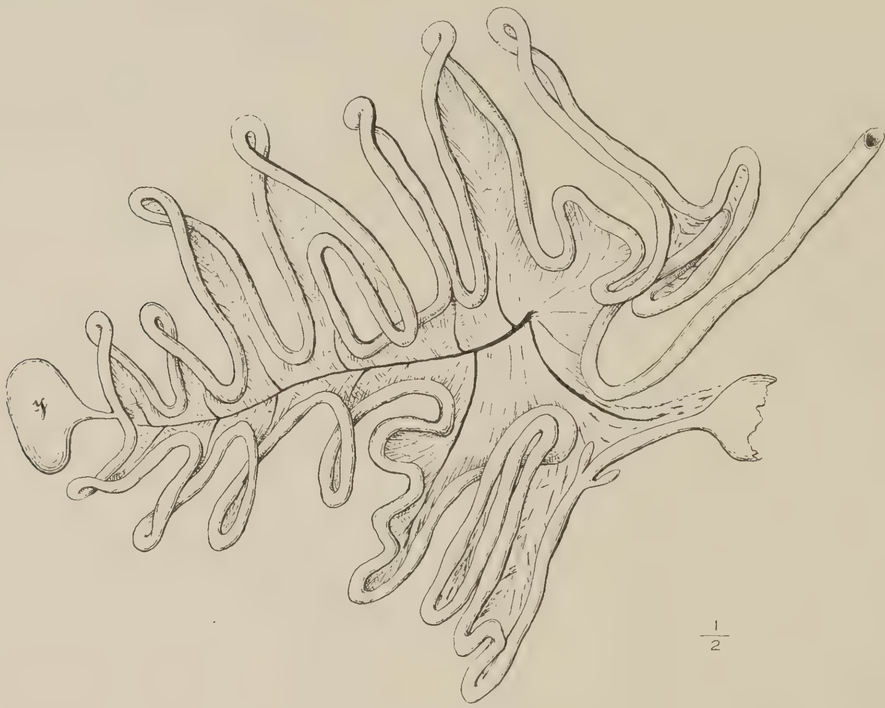


FIG. 8.—THE INTESTINAL TRACT, MINUS THE DUODENAL LOOP, OF THE YOUNG EMPEROR PENGUIN. Note the position of the yolk sac (*y*).

## VIII.—SUMMARY.

PALÆONTOLOGY has thrown no light on the problem of the ancestry of the penguins, for the oldest known remains, which occur in the earliest tertiaries (Eocene and Miocene) differ from those of living penguins only in very slight particulars.

It is significant that penguins are, and always have been, confined to the Southern Hemisphere, and that only fossil remains thereof have been found on the South American Continent, New Zealand, and, as a result of the Swedish Antarctic Expedition, in the South Shetlands; no less than six new genera having been described from Seymour Island.

Our knowledge of fossil penguins dates back to the time when Huxley (8) first described the tarso-metatarsus of a species which he estimated must have stood 4 feet to 5 feet high and named *Palæeudyptes antarcticus*; but there is reason to believe that he under- rather than over-estimated the size. This fragment was from the white Kakanui limestone of Otago. Later, Hector (7) redescribed this with numerous other bones which had been found in this same limestone, exposed at low water in a reef at Woodpecker Bay. These remains he referred to Huxley's species.

Five species, referred to the genera *Palæospheniscus* and *Paraptenodytes*, have been described by Professor Ameghino (1) from remains found in Miocene formations of Patagonia.

The remains brought back by the Swedish Antarctic Expedition (1901–1903) have proved to be of considerable interest. They were obtained from the older tertiaries (apparently Eocene) of Seymour Island, one of the South Shetlands, lying to the north-west of Ross Island. These have formed the subject of a beautifully-illustrated memoir by Dr. Carl Wiman (22), and deserve some mention here.

Unfortunately, as in other cases, no skulls were found, but trunk and limb bones occurred in some plenty. Altogether some six genera are described, all of which show somewhat less specialisation than recent penguins. Probably, however, not more than five genera will be allowed to stand, for the bones referred to the genus *Cladornis* do not seem to be those of a penguin.

In size these newly described forms range from a species not larger than the black-footed penguin (*Spheniscus demersus*) of the Cape to giants of twice the size of the Emperor Penguin.

The largest species (*Anthropornis nordenskjoldii*), like *Palæeudyptes antarcticus*, occurred in Eocene times, and stood apparently some six feet high as against the three feet of the modern " Emperor."

The wings of these early forms appear to have been relatively longer than recent penguins, and further to have approximated more nearly towards the flying wing, since the radial and ulnar condyles of the humerus were much larger, rounder, and wider apart than in living penguins. Similarly the proximal end of the humerus had as yet undergone relatively little change, but at the distal end of the shaft the Epicondylus ulnaris had even then become produced backwards and grooved for sesamoids as in recent types. And what is true of the genus *Anthropornis* is true also of the later Miocene genera in this matter. Similarly in all the Eocene forms, in the manus the pollex is found to be less completely fused with the Mc. II. than in living species; but no phalangeal bones have so far been discovered, hence there is no record as to whether the II.–III. digits terminated in ungual phalanges. But the Miocene forms appear to differ in no way from modern species.

The coracoids of the fossil genera all show a larger procoracoid, and this is especially noticeable in the Eocene *Anthropornis*, in which this bone is relatively shorter and broader than in *Aptenodytes*. But it is in the tarsometatarsus that these extinct South Shetland forms differ most widely from their modern relatives, inasmuch as this is, in the first place, relatively much longer than in any living species. In *Anthropornis*, for example, it is, relatively, more than twice as long as in *Aptenodytes*. Thus in the latter genus the breadth nearly equals the length, while in *Anthropornis* the breadth is less than half the length. In *Delphinornis* and *Eosphæniscus* the same elongated metapodials are also to be noted. Among living penguins *Eudyptula* has, relatively, the largest tarsometatarsus, the width being about one-third the length, while in

*Aptenodytes* the width is nearly as great as the length. A feature which is somewhat remarkable about the metapodials of the fossil forms is the fact that they are more completely fused one with another than in living species. In the latter, as is well known, the metatarsals are more or less divided by deep grooves along the anterior aspect of the metatarsus, while these grooves are pierced in *Aptenodytes* by a pair of intermetatarsal fenestræ, and in other genera by a single foramen between the inner and median metatarsals. In the fossil forms only the inner groove is present, and this is pierced near its upper end by a small foramen, except in *Eosphæniscus*, in which the foramen is enlarged to form a long slit.

Again, in the fossil genera the trochleæ are set much wider apart than in living genera, and this is especially true of the trochlea of Mc. II., which diverges widely from the trochlea of Mc. III.

This shortening of the metatarsals is in part due to the lessened use of the legs, but the presence of the intermetatarsal grooves would appear to be a secondary, and not a primitive, character, as has hitherto been supposed. Nevertheless, as we have shown (p. 20), in the embryo the shafts of the metatarsals are more complete than in any other living birds.

Dr. Wyman, the author of the monograph on these fossils, attributes the shortening of the metatarsals in living penguins to their plantigrade habits, but in this, of course, he is in error, as these birds are *not* plantigrade.

All that can be gleaned from fossils, then, is that penguins have probably descended from birds which possessed full powers of flight, and this probability becomes converted into a certainty when the embryological evidence comes to be examined. But the question of the precise affinities of this group must still be regarded as an unsolved problem, the intense specialisation which these birds have undergone obliterating much of the necessary evidence.

It would seem, however, that we must regard the Steganopodes as representing a common ancestral stock from which have descended the Sphenisci, Colymbi, and Tubinares, on the one hand, and the Ciconiæ, Accipitres, and Anseres on the other. And this conclusion is based on a consideration of a number of anatomical characters into which there is no need to enter here. But among them I would specially mention two, inasmuch as they have not hitherto been used in this connection. These are the nature of the relations between the squamosal and parietal before their fusion, and the nature of the palate at the same period.

As I propose to deal elsewhere in detail with these characters, I will confine my remarks thereon at present to those types immediately concerned with the subject in hand—that is to say, to the relationship of the penguins to the divers and petrels and to the Steganopodes.

At the stage in question all are schizognathous, and the penguins and divers, like the Steganopodes, have a large squamosal, articulating with the hinder portion of the postero-infero angle of the parietal, agreeing in this with the struthious types. The

petrels, however, in so far as I have been enabled to study skulls of the necessary age, differ conspicuously in that the squamosal has assumed an arcuate form, the upper limb thereof extending along the infero-lateral border of the frontal. This change in the form and relations of the squamosal, by which it comes into combination with the frontal, is met with in the more highly specialised types of many quite unrelated orders of birds, though the details of the union vary. It is associated generally with an increase in the size of the frontal, and a decrease in that of the parietal, but the net result appears to be a larger cranial cavity. The peculiar form of the squamosal in the Tubinares, it is curious to note, occurs nowhere else except among the Alcidæ—the most highly specialised of the plovers (*Charadrii*).

The Steganopodes have lost the external nares, excepting only the Phæthontidæ, in which, however, they are much reduced. The Sphenisci have similarly suppressed the external nares completely, except in *Spheniscus*, in which, however, they have ceased to be functional. The manner of this sealing up of the nares is interesting. In the penguins, this closing has been brought about simply by the growing together of the rhamphothecal horny tissue surrounding the aperture, leaving the osseous nares unaffected. In Spheniscus, however, a minute though functionless aperture still remains, yet here the osseous nares have also begun to close. Among the Steganopodes, the cormorants and gannets have completely closed the osseous narial aperture by bony tissue, and show but the faintest traces of an aperture in the rhamphotheca ; in the pelicans there is no trace externally of these apertures, and only minute apertures in the place of the normal fossæ in the skull. The process of reduction of the osseous fossa is interesting, inasmuch as in the nestlings of the Phæthontidæ, for example, the skull is schizorhinal, while in the adult it becomes holorhinal. This is true also of the cormorants and gannets, though here the fossa becomes almost obliterated. This reduction of the nares is the more remarkable because in the Colymbi, which, like the penguins, obtain all their food by diving, the nostrils are normal. The Tubinares show a similar reduction of the nares, but in no case does this end in complete suppression of the aperture. If we turn to the Ciconiæ, Anseres, and Accipitres we find the same phenomena ; the more primitive types have the largest nares. Thus, then, this peculiarity appears to have been the common heritage of all the forms belonging to this great Steganopod branch of the Avian tree, except the Colymbi. In their pterylosis the penguins are the most primitive of all the Neognathæ (Carinatæ), and after them the Steganopodes show the broadest pteryla.

Dr. Chalmers Mitchell in his extremely valuable treatise on the Intestinal Convolutions of Birds treated the characters of the patterns of the gut as though this portion of the alimentary canal were the whole animal. Although, as he pointed out, the evolutionary inferences therefrom cannot be regarded as exact indications of affinity between the different groups of birds, yet they follow surprisingly close on the results obtained by taking the sum of all the anatomical characters. In so far as it bears on the present paper, then, we may remark that he showed that the characters of the intestual

convolutions of the Colymbi, Sphenisci, Steganopodes, Ciconiæ, Accipitres and Anseres were derived from a common metacentre ; but that those of Colymbi were more primitive than those of the Steganopodes, Sphenisci or Tubinares. The Steganopodes, indeed, in this particular represented a new metacentre from which the penguins and petrels, in common with the storks and diurnal birds of prey, took their rise, each group evolving along a radius of its own. This agrees extremely well with the characters which I have brought forward, drawn from the plumage and skull in the present connection. His scheme also embraces all the forms included in Dr. Gadow's Colymbo-pelargomorphine brigade. But we should possibly be nearer the truth in regarding the Steganopodes as representing the stock from which these several orders were derived, and not the Palamedeæ, as the evidence of the intestinal convolutions alone would seem to indicate.

With regard to the question of the compound rhamphotheca in the penguins, there can be little doubt but that the primitive beak-sheath was composed of several separate pieces, and that in the Tubinares these have attained their highest phase of development, while in other groups there is a tendency for these plates to fuse: so much so, that in each group exhibiting this type of rhamphotheca some members will be found in which all traces of distinct plates have been lost. Thus among the Steganopodes Phæthon is holothecal; and what is somewhat remarkable, so also is *Plotus*, while in the nearly allied Phalacrocoracidæ the sheath is still compound.

That the deep lateral grooves along the rhamphotheca of the penguins, extending almost to the tomium, are relics of distinct lateral plates (labials) there can be no doubt; but if this sheath is on this account to be regarded as compound, so also must that of the long-billed Charadriæ, as well as of many Ciconiæ and Rallidæ. But this sheath in the penguins differs further from that in the Tubinares, since it lacks all trace of the "rostrale," so well developed in the Tubinares and Steganopodes.

As a factor in classification, there can be no doubt the structure of the beak-sheath is valueless, that is to say, it is of no value in determining questions of affinity; inasmuch, as Dr. Lönnberg (10) has recently shown, traces of these originally separate elements occur more or less distinctly throughout the whole class Aves.

As a measure of specialisation this character is certainly useful. Thus *Aptenodytes*, *Pygoscelis*, and *Eudyptula* are less specialised than *Catarrhactes* or *Spheniscus*, although in the former of these two the plates are greatly thickened, simulating those in the rhamphotheca of the Tubinares.

Perhaps the most interesting facts which this enquiry has brought out are those connected with the nature of the nestling plumage, and the light they throw on the probable character of the primitive plumage. But these points have been dealt with so fully (p. 10) that there is no need to deal further with the matter here.

Though the method of moulting in the penguins differs from that in all other birds, it is not, as has been stated, comparable in any way to the sloughing of the skin in snakes (p. 13); while for the sloughing of the lateral rhamphothecal plates of the lower jaw, described by Dr. Wilson, we may find a parallel in the shedding of a part of

the sheath of the upper jaw in the puffin (*Fratercula arctica*), or in the moult of the claws in grouse.

Some day another Antarctic Expedition will be sent out, when it is to be hoped that, so far as the penguins are concerned, special efforts will be made to secure the earlier nestling stages of the King, and the latter stages of the Emperor Penguin—full-grown nestlings of the latter being especially needed; while of both species the early and middle embryonic stages are wanted. Ripe embryos will add but little of real value to our knowledge, since they differ but little of course from the newly-hatched nestling, and furthermore, several examples are among the spoils of the expedition herein concerned. A few adults of both species would certainly be useful if preserved entire, *in spirit*, or in ice.

Bearing in mind the temperature of the air in which these birds live, observations on their breathing would be of value, since, as we have pointed out, the external nares are closed; thereby respiration has to be carried on by way of the mouth. This being so, it is possible that observations may show that some mechanism has been adopted whereby the air taken in at the mouth can be retained and warmed before being passed on to the lungs. It may be that the tracheal septum, by increasing the vascular surface of the interior of the trachea, may serve some such purpose. This septum can, however, hardly have been developed to serve this special end, inasmuch as it occurs in the embryos of all birds, and the adult of some other species which live neither in a specially cold atmosphere nor have closed nares.

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## Description of Plate.

Skulls (left side view) and wings (dorsal aspect) of nestling Penguins.

Fig. 1. Skull of *Catarrhactes chrysocome.*
,, 2. ,, *Spheniscus demersus.*
,, 3. ,, *Pygoscelis adeliæ.*
,, 4. ,, ,, ,, (full grown).
,, 5. ,, ,, *papua.* ,,
,, 6. ,, *Aptenodytes forsteri.*
,, 7. Hemipterygoid of *Aptenodytes forsteri.*
,, 8. Skull of *Aptenodytes forsteri.*
,, 9. Right wing of *Pygoscelis adeliæ.*
,, 10. ,, ,, *Aptenodytes forsteri* (later stage).
,, 11. ,, ,, *Pygoscelis adeliæ* (adult).

| | | | |
|---|---|---|---|
| Als. | = alisphenoid. | Ph.[1] | = phalanx 1. |
| bp. | = basipterygoid process. | r.[1] | = radiale. |
| c. | = condyle. | r. | = radius. |
| dc.[1. 2. 3.] | = distal carpalia, 1. 2. 3. | u[1] | = ulnar. |
| fr. | = frontal. | u. | = ulna. |
| h. | = humerus. | so. | = supraoccipital. |
| hept. | = hemipterygoid. | s.o.g. | = ,, orbital groove. |
| l.o. | = lateral occipital. | sq. | = squamosal. |
| p. | = parietal. | I. II. III. | = Digits I. II. III. |

Figs. 1–6 and 8. Slightly reduced ($\frac{7}{8}$ nat. size).
Fig. 7. Enlarged.
,, 9. Four times natural size.
,, 10. Five times natural size.
,, 11. Slightly reduced ($\frac{7}{8}$ nat. size).


SKULL AND WINGS OF YOUNG PENGUINS.

H. Grönvold del.

Collo Morgan & Kidd, Richmond, S.W

# IV.—FISHES.

By G. A. Boulenger, F.R.S.

(Two Plates.)

The collection is a very small one, consisting of representatives of ten species only, from within the Antarctic Circle, but of these four are here described as new. In addition to these species an example of a very large *Notothenia*, apparently closely related to *N. colbecki*, Blgr., was obtained, harpooned, with a seal, from a hole at the Winter Quarters. It was in a damaged condition, the head gone, and the caudal fin partly torn away. All I have seen of the fish is a photograph and the bones of the body. Dorsal with viii, 27 rays, anal with 26; scales, in a longitudinal series, 125. Total length, 3 ft. 10 ins.; weight, 39 lbs. (without the head).

### 1. Trematomus borchgrevinki.

Boulenger, Rep. 'South. Cross' (1902), p. 179.

Ten specimens, measuring from 170 to 250 millimetres. Winter Quarters, taken in April and December, 1902, and May, 1903.

### 2. Trematomus hansoni.

Id., op. cit., p. 180.

Twenty-five specimens, measuring from 115 to 290 millimetres. Winter Quarters, taken in March and April, 1902; also to the south-west of the Balleny Islands, at a depth of 254 fathoms, March 4th, 1904.

### 3. Trematomus bernacchii.

Id., op. cit., p. 181.

Forty-two specimens, measuring from 100 to 280 millimetres. Winter Quarters, taken throughout the year.

### 4. Notothenia longipes.

Steindachner, SB. Ak. Wien. lxxii. i. (1876), p. 70.

Three specimens, measuring up to 120 millimetres, from Tent Island, January 3rd, 1904.

### 5. Notothenia nicolai.

Boulenger, op. cit. p. 184.

Five specimens, measuring up to 100 millimetres. Winter Quarters, February and March, 1902, and February, 1904.

### 6. Notothenia scotti.

(Plate I., fig. 1.)

Depth of body five and a-half times in the total length; length of head thrice and one-third. Diameter of eye twice and four-fifths in the length of the head; interorbital width nine times; maxillary extending to below the anterior border of the eye; lower jaw not projecting; head densely scaled, except on the upper surface of the snout. Gill-rakers short, eleven on lower part of anterior arch. Dorsal fin V, 32; longest rays nearly half the length of the head. Anal fin 34; longest rays two-fifths the length of the head. Pectoral fin rounded, three-fourths the length of the head, reaching beyond origin of anal. Ventral also three-fourths the length of the head. Caudal fin rounded. Caudal peduncle as long as deep. Scales $56\frac{5}{16}$; lateral lines $\frac{40}{18}$(?) Brownish, with irregular darker spots, first dorsal fin, and a blotch on the posterior part of the dorsal and anal, black. Total length, 115 millimetres.

A single badly preserved specimen taken at a depth of 300 fathoms off the Ice Barrier, January 27th, 1902.

### 7. Notothenia hodgsoni.

(Plate I., fig. 2.)

Depth of body four and one-third to five times in the total length; length of head thrice and a half to thrice and four-fifths. Diameter of eye thrice to thrice and a-half in the length of the head, interorbital with thrice and a-half; maxillary extending to below the anterior third of the eye; lower jaw not projecting; interorbital region and occiput naked. Gill-rakers long, 16 to 18 on lower part of anterior arch. Dorsal fin VI–VII, 34–38, longest rays about half the length of the head. Anal fin 33–35, longest rays about one-third the length of the head. Pectoral fin rounded, as long as or a little shorter than the head, reaching beyond origin of anal. Ventral fin about three-fourths the length of the head. Caudal fin truncate. Caudal peduncle as long as deep. Scales 90–95 $\frac{8\text{–}9}{28\text{–}30}$; lateral lines $\frac{43\text{–}52}{8\text{–}10}$, sometimes very indistinct. Brownish, with dark spots, which may form irregular vertical bars on the side of the body.

The largest specimen, from the stomach of a seal (Sept. 30, 1903), measures 160

millimetres, but is partially digested. There are twenty-four specimens, up to 95 millimetres, from the winter quarters, taken throughout the year. All more or less poorly preserved. This species is most nearly related to *N. colbecki*, differing in the more numerous dorsal and anal rays, somewhat larger scales, and truncate caudal fin.

### 8. Champsocephalus macropterus.

(Plate II.)

Body feebly compressed, gradually attenuate towards the very short caudal peduncle. Head large, twice and three-fourths to twice and four-fifths in the total length, twice and one-fourth to twice and a-half as long as broad; snout spatulate, nearly half the length of the head, with a hook-like spine in front, some longitudinal striæ on its upper surface; diameter of eye five to five and a-half times in the length of the head, once and a-half to once and two-thirds in the width of the interorbital region, which is smooth and concave; jaws equal in front, with a double series of slender, sharply pointed, feebly curved teeth; maxillary extending to below the anterior third of the eye; operculum produced above into a group of four spines, the upper of which is shaped like a Lochaber axe, having an anterior, recurved hook. Dorsal fin with XIII–XIV, 29–32 rays, the anterior portion commencing at a short distance from the occiput, the posterior commencing immediately behind the anterior; the spines flexible and produced into filaments much longer than the articulated rays, measuring about two-thirds the length of the head. Anal fin similar to the second dorsal, but a little shorter, with 25 to 27 rays. Pectoral fin as long as the ventral, about two-thirds the length of the head. Caudal fin small.* Body naked, with a series of 64 to 77 soft tubular scales forming the principal lateral line, high up on the back from the gill-opening to the caudal peduncle, but not extending to the root of the caudal fin; a very short second lateral line, of 3 to 7 scales, on the middle of the caudal peduncle. Head and body pale olive † with blackish spots and vermiculations, forming more or less regular cross-bands on the body, these cross-bars enclosing a lighter field; the membrane between the first dorsal and the ventral fins blackish; isis pale golden.

Eleven specimens, measuring from 65 to 240 millimetres, the largest being a female with the oviducts full of ripe eggs, measuring 3 millimetres in diameter. They were obtained from the stomach of a Weddell Seal; winter quarters; Sept. 27, 1903. The head of another specimen was taken from a seal's stomach, March 14, 1903. The very large first dorsal fin well distinguishes this species from Dr. Günther's *C. esox*. With respect to this character the *C. gunnari* recently described by Dr. Lönnberg is intermediate.

In addition to the specimens described above, there are three very young and post-larval specimens, measuring from 20 to 30 millimetres, obtained at the winter quarters,

* Its exact shape cannot be made out from any of the specimens.

† According to a coloured sketch by Dr. Wilson.

February 2nd, 1903, which I must refer to the same species. As in *Trachinus*, the post-larval fish is remarkable for the very large size of the ventral fins, which are about three times as long as the pectorals, and of an intense black.

Other post-larval fishes, collected with the above, and also a few days later, February 23, 1903, appear to be referable to *Gymnodraco acuticeps*, Blgr., and are also remarkable for the very long ventral fins; there are two black bars on the body and a third at the root of the caudal fin.

### 9. Bathydraco macrolepis.

(Plate I., fig. 3.)

Body slightly depressed, gradually attenuate towards the caudal peduncle; its depth nine times in the total length. Head large, three times in the total length, twice and one-fourth as long as broad; snout spatulate, one-third the length of the head; diameter of eye one-fourth the length of the head, and three times the width of the interobital region; jaws with broad bands of villiform teeth, the lower projecting beyond the upper; maxillary extending to below the anterior border of the eye. Gill-rakers moderately elongate, widely set, six on lower part of anterior arch. Seven branchiostegal rays. Dorsal fin with 39 rays; its base slightly longer than its distance from the end of the snout, the longest rays two-fifths the length of the head. Anal fin with 29 rays, the longest measuring two-sevenths the length of the head. Pectoral fin longer than the ventral, three-fifths the length of the head. The distance between the extremity of the ventral and the vent one-fourth the length of the fin. Caudal fin rounded, half as long as the head. Scales strongly ctenoid, $96\frac{5}{12}$; lateral line 56, extending from the upper extremity of the gill-cover to the root of the caudal fin. Uniform brownish, posterior half of the ventral fins blackish. Total length, 210 millimetres.

A single specimen, taken at a depth of 252 fathoms, to the south-west of the Balleny Islands, March 4th, 1904. Distinguished from *B. antarcticus*, Gthr., by the much larger scales, fewer and longer gill-rakers, and fewer branchiostegal rays.

### 10. Pleuragramma antarcticum.

Boulenger, op. cit., p. 187.

Twenty specimens, measuring up to 200 millimetres, mostly from the stomachs of seals, January 23rd, 1903, and February, 1904, but one found among ice crystals at the seal hole off Cape Armitage, September 22nd, 1902, and one taken at a depth of 254 fathoms to the south-west of the Balleny Islands, March 4th, 1904.

Series of young showing the development were also obtained by Mr. Hodgson. In specimens measuring about 20 millimetres, the body is very elongate, and a series of black dots borders the base of the dorsal and anal fins.

# EXPLANATION OF THE PLATES.

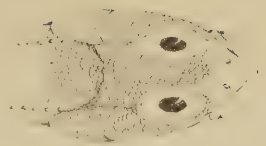
## PLATE 1.

Fig. 1.—*Notothenia scotti.*
,, 1*a.*—*Notothenia scotti.* Upper view of head.
,, 2.—*Notothenia hodgsoni.*
,, 2*a.*—*Notothenia hodgsoni.* Upper view of head.
,, 3.—*Bathydraco macrolepis.*
,, 3*a.*—*Bathydraco macrolepis.* Upper view of head.
All natural size.

## PLATE 2.

*Champsocephalus macropterus.* Adult, natural size, with upper view of head; and young, enlarged three times, with upper view of head.

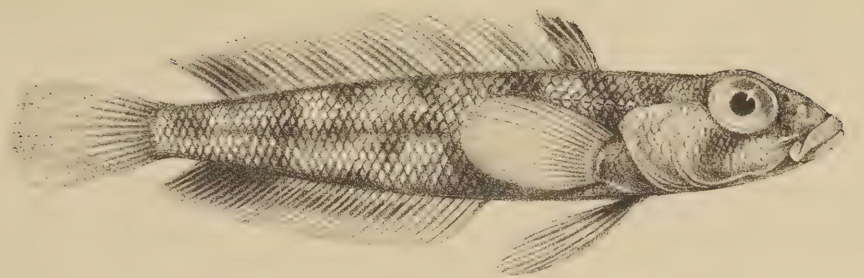
Antarctic (Discovery) Exp. Fishes. Pl. I. J. Green del. et lith.



1 a.

3 a.

2 a.



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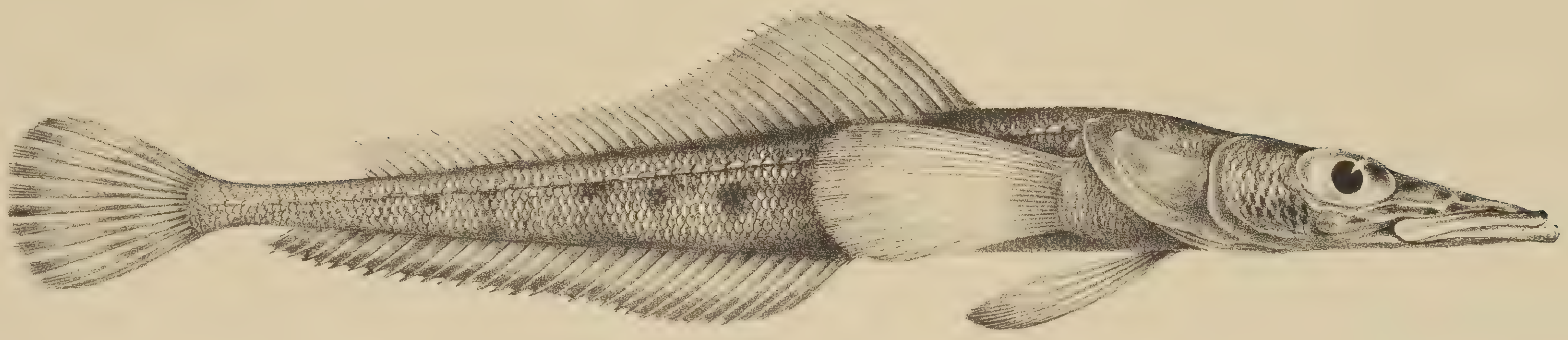

3.

Antarctic (Discovery) Exp.

Fishes. Pl. 2

J. Green. del et lith.

# PTEROBRANCHIA.

# CEPHALODISCUS.

By W. G. RIDEWOOD, D.Sc., Lecturer on Biology at St. Mary's Medical School, University of London.

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## INTRODUCTION.

The genus *Cephalodiscus* was founded upon material dredged by the 'Challenger' in 1876 from a single locality, in the Straits of Magellan, Station 311. Since the publication of the full report upon that species (*C. dodecalophus*) in 1887 by Professor M'Intosh and Dr. S. F. Harmer (**19**), many papers have been written upon its anatomy, mode of budding, and its systematic position, notably by Cole (**2**), Delage and Hérouard (**3**), Ehlers (**4**), Fowler (**5**), Harmer (**7, 8, 9**), Kemna (**11**), Lang (**12**), Masterman (**20–28**), Schepotieff (**29**), and Spengel (**31**). No special methods were adopted for the preservation of the material, so that the minuteness with which the various investigators have succeeded in elucidating the histological details of the polypides is not a little remarkable.

In 1903 (**1**) Andersson notified the re-discovery of *Cephalodiscus* in the region of the Falkland Islands by the Swedish Antarctic Expedition, but until the full report is issued it is not possible to say whether this is a new species or not.

In July of the past year (1905) was published the report on the Pterobranchia of the 'Siboga' Expedition (**10**) by Dr. S. F. Harmer, containing a description of two new species of *Cephalodiscus* obtained on the 'Siboga' Expedition (*C. gracilis* and *C. sibogae*) and a third species obtained from the South end of the Corea Strait (*C. levinseni*).

The only known polypides of *C. dodecalophus* are females, the colony of this species being apparently dioecious ; the known specimens of *C. gracilis* are all females, those of *C. sibogae* are males and neuters, and those of *C. levinseni* females.

The material obtained by the 'Discovery' consists of two species, the polypides of both of which have an ovary and a testis, or two ovaries, or two testes. The one species is bulky, and with large, deeply pigmented polypides, and the other has a tubarium with long spine-like processes, like that of *C. dodecalophus*, but more massive, and with the central cavity less divided up. The former species was named *C. nigrescens* in a short account published by Lankester in the Proceedings of the Royal Society of last year (**15**). The second species I now name *C. hodgsoni*, after Mr. T. V. Hodgson, the biologist of the 'Discovery' Expedition. Eight specimens (pieces of colony) of this were obtained, five on one day, one two days previously, the seventh four months later, and the last a fortnight later still. The dates and localities are given on p. 49.

I take this opportunity of offering my thanks to Professor Ray Lankester for having entrusted to me the drawing up of the Report on *Cephalodiscus*, and I wish further to express my indebtedness to him for frequent and valuable suggestions and advice given during the progress of the investigation.

## DIAGNOSIS OF A NEW SPECIES OF *CEPHALODISCUS* (*C. hodgsoni*).

The principal characters of *C. hodgsoni* are as follows:—*C. hodgsoni* n.sp. (fig. 1, plate 2)—tubarium, an irregularly branching tube, with lumen varying in size, but with inner surface smooth, and not with partial septa and trabeculae; ostia oval, about 3·3 by 2·3 mm., with four or five long radiating spines, simple or forked; polypides colourless or nearly so, with no black or brown pigment; males, females, and hermaphrodites (with one ovary and one testis) occurring mixed in the same colony, indistinguishable externally; plumes twelve, each with an end bulb, in the epidermal cells of which are refractive colourless beads; free eggs found within the cavity of the tubarium measure about ·45 mm. across.

## CONSIDERATION OF THE CHARACTERS SERVICEABLE FOR THE DISCRIMINATION OF THE SPECIES OF *CEPHALODISCUS*.

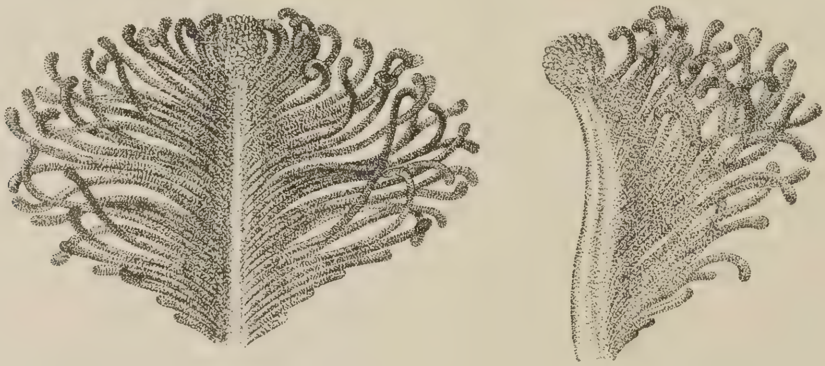
In reviewing the six species of *Cephalodiscus* of which diagnoses have up to the present been published,* one cannot fail to be struck by the close agreement in general structure that exists between the polypides of the various species. Were it not that the males of *C. sibogae* have a reduced alimentary canal, and the plumes reduced to two, one might draw up a general description of a polypide which with very slight alterations, having reference to the size of the body as a whole, the proportions of the buccal shield, stolon and stomach, the number and shape of the plumes, and the degree of pigmentation of the surface, might be made to apply to the polypides of any species. The details of the structure of the notochord, gill-slits, proboscis canals, collar canals, and gonads are almost identical in all. It becomes necessary, therefore, to look mainly to the tubarium for features which shall serve to distinguish one species from another.

The extreme mobility of the buccal shield renders a comparison of the shields of the various species a matter of practical difficulty, and one can only utilise this organ for taxonomic purposes by taking an average of measurements of a large number of shields of each species. The structure of the shield is essentially the same in all; the curved red line is constant, and the posterior lobe is thinner than the anterior.

The number of plumes is not constant in polypides of the same species, but the degree of variation is not the same in all species. In *Cephalodiscus dodecalophus*, *C. levinseni*, and *C. hodgsoni* the number is almost invariably twelve; in *C. nigrescens*, on the other hand, the average number is fourteen, but there may be as few as twelve or as many as sixteen. The number of plumes in *C. gracilis* is stated by Harmer to be ten; the plumes of *C. sibogae* are eight in neuter individuals and two in the males.

* The description of Dr. Andersson's specimens has not reached me at the time of writing, and the new species of *Cephalodiscus* dredged by Dr. Gilchrist in the Cape Seas has not yet been described.

The range in the number of pinnules of the plumes in the same species, and even in different plumes of the same individual, is too wide to allow of such character being utilised for purposes of discrimination. Although the two plumes of the males of *C. sibogae* have no pinnules, those of the neuter individuals are provided with pinnules resembling those of other species. The massiveness of the axes of the plumes of *C. nigrescens* is distinctive of that species, but as regards the form of the apex it is not easy to say whether in *C. nigrescens* the apex is swollen or not, it varies so much with the different degrees of extension and contraction of the plumes (*cf.* figs. 23 and 24, plate 5). Terminal bulbs with refractive colourless beads such as occur in *C. dodecalophus* (text-fig. 1) are met with in *C. hodgsoni* (figs. 31 and 32, plate 5), but there are no such swellings in the polypides of *C. levinseni*, in the neuter polypides of *C. sibogae*, nor in the adults of *C. gracilis*, although in the buds of the last species they occur on the first and sometimes on the second and third plumes, and occasionally persist in the adult stage (**10**, p. 20). In males of *C. sibogae* the refractive beads occur along the whole course of the two pinnule-less plumes.



TEXT-FIGURE 1.—*Cephalodiscus dodecalophus ;* plumes seen from the aponeural aspect and from the side.

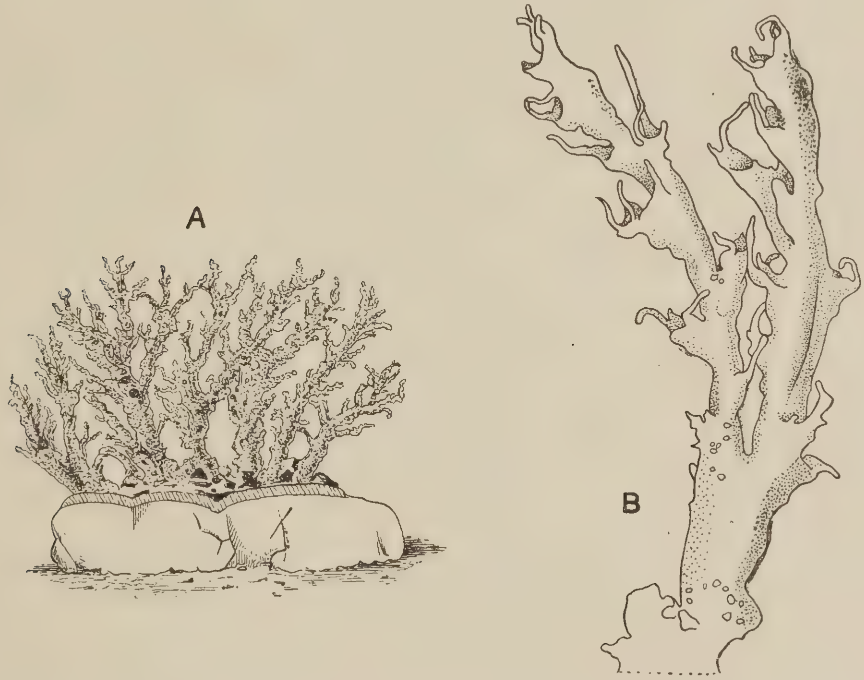
The size of the body of the polypide varies somewhat with the condition of the gonads, but it is fairly uniform for the same species, and would be a useful character if one could estimate the bulk or the weight of the body. In consequence, however, of the great mobility of the parts, and their capacity for expansion and contraction, the linear measurements are not very reliable, and the length of the body of *C. levinseni* and *C. nigrescens* may be an excessive index of the bulk of the body in consequence of the limitation imposed upon the width of the body by the narrowness of the tubular cavity in which the polypide dwells. *C. dodecalophus* and *C. hodgsoni*, on the other hand, being less restricted, have a body less cylindrical.

The measurements found to be most reliable are those from the front of the buccal shield to the posterior end of the visceral mass. The length of the body of *C. dodecalophus* is usually given as 1 mm., but it is not explained how this measurement is taken ; presumably one is expected to measure from the anus to the end of the visceral mass, but even then the recorded measurement falls short of the actual size. The average length of the polypide from the front of the buccal shield to the end of the

visceral mass is 1·5 mm., and from the ends of the plumes to the end of the visceral mass about 2 mm.

The polypides of *C. hodgsoni* are a little larger than those of *C. dodecalophus*, and those of *C. nigrescens* considerably so, the length from the front of the buccal shield to the end of the visceral mass of the last species being 4·5 mm., *i.e.*, three times the corresponding measurement of *C. dodecalophus*; but the same ratio is not maintained in the width of the body. The polypides of *C. levinseni* are about as long as those of *C. dodecalophus*, although more cylindrical, and those of *C. gracilis* and *C. sibogae* (neuter individuals) are smaller.

The length of the stolon and its mode of curvature, whether towards the mouth or away from it, are characters that can only be employed in a very general way for dis-



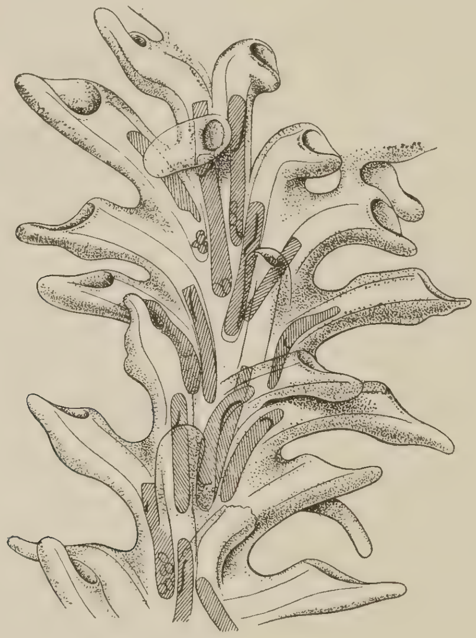

TEXT-FIGURE 2.—*Cephalodiscus sibogae.*—A, — colony attached to a stone (× 1½). B, — a couple of branches more highly magnified. The cavity of the tubarium is continuous, and opens by several ostia. (Copied from Harmer, **10**, plate 1, fig. 2 and plate 2, fig. 18.)

criminating purposes. The differences depend almost entirely upon the amount and the mode of distribution of the longitudinal muscle fibre of the stolon. If, as is usually the case, there is more muscle on the antero-ventral wall of the stolon than elsewhere, the animal dies with the stolon curled towards the mouth owing to the contraction of these fibres in its death struggles, but this curvature is not apparent if the animal dies tightly fitted into a tubular space, as do the polypides of *C. nigrescens* and *C. levinseni.*

Some species are remarkable for the great development of epidermal pigment, which causes them to appear black. This is so with *C. nigrescens* and *C. sibogae. C. gracilis* is described as having a median line of pigment on the anterior side of the

stolon (**10**, p. 52), and Harmer also states that deserted stolons of this species are deeply pigmented (**10**, p. 93). The red line of the buccal shield is absolutely constant, being present even in the shield of the reduced males of *C. sibogae.* The red pigment of the oviduct is also constant, and is sometimes, though rarely, present in the testis-duct in *C. nigrescens* and *C. hodgsoni.* Harmer, by saying nothing of red pigment around the testicular orifices in *C. sibogae,* leads one to conclude that there is none.

The free ova found in the cavities of the tubarium in some of the species vary somewhat in size, although they are all heavily yolked, and are all ovoid in shape, and pale yellow in colour. Those of *C. nigrescens* are the largest, and measure ·6 mm. across; those of *C. hodgsoni* are 4·5 mm.; and those of *C. dodecalophus, C. gracilis,* and *C. levinseni* measure between ·3 and ·4 mm.



TEXT-FIGURE 3.—*Cephalodiscus levinseni,* portion of a branch (× 5). The dark bodies are the polypides. Each polypide occupies a separate cavity of the tubarium, opening by a single ostium. (Copied from Harmer, **10**, plate 2, fig. 11.)

One is thus left with the tubarium to deal with, and the architectural details of the test are almost in themselves sufficient to enable one to judge of the species to which the polypides that produced it belong. The size and 'habit' of the tubarium of the different species are much more different than are the size and shape of the polypides. The colony of *C. gracilis* and *C. sibogae* (text-fig. 2) is diminutive, that of *C. nigrescens* is exceptionally bulky and massive. The branching of *C. dodecalophus* is straggling, the branches of *C. hodgsoni* are more closely set. The spine-like processes of the exterior of the tubarium vary in length and thickness in the different species; they may occur one to each ostium, or several, or may occur apparently independently of the ostia. They may be long, thin spines, or

may be but short, thick lips to the peristomial tube. Most important of all, however, is the isolation of the polypides of certain species in tubular spaces in the tubarium, in contrast with the occurrence of all the polypides of the colony in one continuous cavity in other species.

Harmer, on p. 6 of his monograph (**10**), gives a list of the generic characters of *Cephalodiscus*; but while attaching the name of M'Intosh as the author of the genus to the name *Cephalodiscus* at the head of the paragraph, he alters the diagnosis of that author by describing the tubarium as "with a continuous cavity or with a separate cavity for each zooid." Until the discovery of *C. levinseni* it was not known that any forms of *Cephalodiscus* existed in which the polypides had separate tubes. The presence of (an average of) fourteen plumes in the polypides of *C. nigrescens*, and the discovery that in both *C. nigrescens* and *C. hodgsoni* hermaphrodite individuals occur, necessitate further alterations in the diagnosis given by Harmer (**10**, p. 6).

The isolation of the polypides in separate tubes within the common test is clearly a feature of great systematic importance, and for the inclusion of species of *Cephalodiscus* in which the polypides are so isolated Professor Ray Lankester has been good enough to suggest the sub-generic name *Idiothecia**. So far as our present knowledge goes there are three such species, viz., *C. levinseni* (text-fig. 3), *C. nigrescens* (plate 1), and an undescribed species obtained by Dr. Gilchrist in the Cape Seas. The remaining species of *Cephalodiscus*, in which the polypides are more social and live together in the same edifice, namely, the type species *C. dodecalophus* (text-fig. 4), and the recently discovered species *C. gracilis* (text-fig. 5), *C. sibogae* (text-fig. 2), and *C. hodgsoni* (fig. 1, plate 2), are included in the sub-genus for which Professor Lankester proposes the name *Demiothecia*†. Dr. Andersson's note (**1**) is not sufficiently detailed to enable one to judge whether the Falkland Islands specimens belong to *C. dodecalophus*, as that author suggests, or not.

## REVIEW OF THE SIX SPECIES OF *CEPHALODISCUS*.

Genus *Cephalodiscus*. Polypides secreting a tubarium of gelatinous appearance, formed of superimposed lamellae, and with ostia upon the surface. Polypides with buccal shield, collar, and trunk. Shield with pedicle arising from middle of upper surface, hollow, the cavity opening typically ‡ by two small pores (proboscis pores) on the dorsal surface. Collar with special paired division of coelom, opening to exterior on each side by a canal (collar canal) near the gill-slit; collar produced

* From ἴδιος, one's own, personal, private, and θήκη, a case, box, vault.

† From δήμιος, belonging to the commonwealth, and θήκη, a case, box, vault.

‡ Proboscis pores, gill-slits, and post-oral lamella have not been recognised in the reduced males of *C. sibogae* (**10**, p. 6), but the neuter individuals of that species conform with the generic diagnosis in these respects.

anteriorly into paired plumes which are usually provided with paired pinnules, and produced postero-ventrally into a post-oral lamella. Trunk large, with distinct division of the coelom, not opening to exterior, and primarily paired. A stolon for the production of buds projects from the ventral side of the trunk region of the body. Alimentary canal bent, mouth posterior to the pedicle of the shield, a notochordal outgrowth from the front of the pharynx, gill-slits leading from the pharyngeal cavity to the side of the body, anus antero-dorsal, near the bases of the plumes. Gonads simple, one pair, with short ducts opening near the anus.

Sub-genus *Demiothecia*. Cavity of the tubarium continuous, and all ostia leading into that cavity.


Text-Figure 4.—*Cephalodiscus dodecalophus*. A, — portion of tubarium cut lengthwise; B, — portion of tubarium cut transversely. The polypides are not shown. The cavity is continuous, irregular, and with several ostia (× 3).

Species *dodecalophus*. *Material*. Obtained by H.M.S. 'Challenger,' in 1876, in the Straits of Magellan, Station 311; depth, 245 fathoms; bottom, blue mud. Described by M'Intosh in *Ann. Mag. Nat. Hist.* (17) and in the Report of the 'Challenger' Expedition (19). *Tubarium*. Colony irregularly branched, and straggling, some of the branches fusing up to form a network, the cross-bars being usually solid. Colony reaching a length of at least 225 mm.; distance between one branch or cross connection and the next about 22 mm.; width of branch, 4 to 6 mm., not including spines; cavity of tubarium partially divided up by bars, ridges, and incomplete partitions (text-fig. 4), ostia numerous, irregularly placed, oval, 1·5 by ·7 mm., sessile, *i.e.*, without peristomial tubes,

even sunk below the general surface; spines long, not very obviously related to the ostia; width of spines about 5 mm. *Polypides* colourless; all known individuals are female. Front of buccal shield to end of visceral mass 1·5 mm. Plumes six pairs, axis of each terminating in an end bulb with refractive colourless beads. Stolon not so long as the rest of the polypide in the contracted condition, commonly directed towards the mouth. Buds, one or two, rarely three. *Free ova* ·33 mm. across.

Species *hodgsoni*. *Material.* Eight specimens dredged by the 'Discovery' in the Antarctic Ocean in 1902–3, in 100 to 300 fathoms. New species. *Tubarium.* Colony irregularly and closely branched (fig. 1, plate 2); distance

TEXT-FIGURE 5.—*Cephalodiscus gracilis*, portion of a colony (× 5). The dark bodies are the polypides and embryos. The cavity of the tubarium is continuous, and opens by numerous ostia. (Copied from Harmer, **10**, plate 2, fig. 15.)

from one branch to the next about 10 mm.; width of branch about 6 mm.; cavity of tubarium with inner surface smooth; ostia oval, 3·3 by 2·3 mm., with four or five long, radiating spines, simple or forked; width of spines ·6 to 1 mm. *Polypides* colourless; males, females, and hermaphrodites (one ovary and one testis), indistinguishable externally; front of buccal shield to end of visceral mass 2 mm. Plumes six pairs, axis of each terminating in an end bulb, with refractive colourless beads. Stolon curved forwards or backwards, average length in contracted state 2 mm. or less. Buds two, sometimes three or four. *Free ova* ·45 mm. across.

Species *gracilis*. *Material.* One specimen, obtained at Station 89 of the 'Siboga' Expedition, East Coast of Borneo, on reef, between tide-marks.

Described by Harmer in Report of 'Siboga' Expedition (**10**). *Tubarium.** Colony very small and delicate; almost colourless tubes, of prostrate habit, supported by foreign object (calcareous branches of the Polyzoon *Tubucellaria*). Extremities of the branches with long spines borne upon the margins of the funnel-shaped ostia, which measure ·8 to 1 mm. across. Width of branches 1 to 1·5 mm. (text-fig. 5). *Polypides.* All known individuals are female. Front of buccal shield to end of visceral mass ·87 to 1·2 mm. Plumes five pairs, small end bulbs with refractive beads present in first pair of arms of the bud, and occasionally on second and third pairs also; they may persist in the adult (**10**, p. 20). Stolon thin, much longer than the rest of the polypide, usually directed away from the mouth, and producing buds in great profusion. *Free ova* ·3 to ·4 mm. across.

Species *sibogae.* *Material.* One specimen, obtained at Station 204 of the 'Siboga' Expedition, at the Northern entrance of Buton Strait, off S.E. point of Celebes, in 75 to 94 mètres. Bottom sand with dead shells. Described by Harmer in Report of the 'Siboga' Expedition (**10**). *Tubarium* with a dense basal encrusting portion, growing on a small rock, with stiff, erect and slightly branched tubes, with numerous foreign inclusions in the substance of the test. Ostia funnel-shaped, more or less alternate on two opposite sides of the branch, ·6 mm. across, produced into a few peristomial spines, stiffer and shorter than those of *C. gracilis.* Width of branch 1 to 2 mm. (text-fig. 2). *Polypides* deeply pigmented; all known individuals are male or neuter. Neuters with elongated trunk region, with excessively long and slender stolon arising from near its aboral end, and producing buds in great profusion; gonads vestigial in buds, usually absent in adults, but occasionally developed into functional testes (**10**, p. 84, and legend to fig. 98). Plumes four pairs, without end bulbs and refractive beads. Front of buccal shield to end of visceral mass ·95 mm. Males with conical body, which passes continuously into the stalk; alimentary canal vestigial; testes occupying most of the trunk and part of the stalk. Plumes one pair, without pinnules, surface with crowded refractive beads, at least in young males. *Free ova* not known.

Sub-genus *Idiothecia.* Cavity of the tubarium multiple; each ostium leading into an unbranched, tubular cavity occupied by one polypide and its buds, and having no connection with the other cavities of the tubarium.

Species *nigrescens.* *Material.* Several specimens, obtained by the 'Discovery' in 1902 off Coulman Island, near Victoria Land, in the Antarctic Ocean, in 100 fathoms. Described by Lankester in Proc. Roy. Soc. (**15**).

* In drawing up this table the distinctive features of *C. gracilis*, *C. sibogae* and *C. levinseni* have been culled from Harmer's monograph; an independent examination of his specimens was not made. It is to be noted that Harmer's orientation of the polypide is not accepted; the surface of the body which he terms anterior is here spoken of as ventral.

*Tubarium.* Colony massive, maximum size of known specimens 190 by 115 mm., with twelve branches (plate 1); maximum width of a single branch 32 mm. Branches roughly cylindrical, with narrowing extremities. Peristomes tubular at the extremity of the branch, and occasionally elsewhere. The abaxial edge produced into a blunt lip; no conspicuous ridge continued down from the extremity of the lip. Width of lumen of tube 1·2 to 1·3 mm. (fig. 10, plate 4). *Polypides* large, 4·5 mm. from front of buccal shield to end of visceral mass; surface deeply pigmented, so as to appear black to the naked eye. Males, females, and hermaphrodites (one ovary and one testis) not distinguishable externally. Plumes usually seven pairs, axes massive, black, no end bulbs with refractive beads. Stolon short, stout, and transversely wrinkled in contracted state, usually directed posteriorly; buds from 2 to 9, some upon secondary stolon where the number is large. *Free ova* ·6 mm. across.

Species *levinseni. Material.* One specimen, belonging to the Copenhagen Museum, obtained off the West coast of Japan, at South end of the Corea Strait, in 100 fathoms. Described by Harmer in the Report of the 'Siboga' Expedition (10). *Tubarium* subcylindrical, slightly branched, reaching a length of at least 132 mm. Ostia at ends of distinct tubular peristomes, which radiate in all directions, at an angle greater than a right-angle, from the principal axis of the branch, each being produced on its abaxial side into a single, short, blunt process or lip (text-fig. 3). Width of branch (from tip to tip of peristomial lips) 12 mm.; width not including peristomial tubes 3 to 5 mm.; width of cavity of tube about ·7 mm.; a ridge present on the outer (abaxial) surface of the peristomial tube, terminating in the end of the lip. *Polypides* colourless; all known individuals are female; body cylindrical, front of buccal shield to end of visceral mass 1·5 mm. or more; stalk of buccal shield exceptionally long. Plumes six pairs, without end bulbs or refractive beads. Stolon thick, about as long as the rest of the polypide, usually directed posteriorly, producing buds in small numbers. *Free ova* ·3 to ·4 mm. across.

## KEY TO THE IDENTIFICATION OF THE SPECIES OF *CEPHALODISCUS.*

Polypides in a common cavity with numerous ostia (sub-genus *Demiothecia*).
- Width of branches, 2 mm. or less; colony diminutive; plumes, less than six pairs.
  - Polypides, black; plumes, four pairs, except in males, which have one pair only . *sibogae.*
  - Polypides with black pigment on stolon only; plumes, five pairs . . . *gracilis.*
- Width of branches, 4 mm. or more; plumes, six pairs.
  - Cavity of tubarium with smooth inner surface; distance from one branch to the next about 10 mm. . . . . . . . . . . . *hodgsoni.*
  - Cavity of tubarium incompletely subdivided by ridges and partitions of irregular shape; distance from one branch to the next about 22 mm. . . . *dodecalophus.*

Polypides in separate cavities, each with a single ostium (sub-genus *Idiothecia*).
  Polypides, black; plumes, seven pairs.
    Colony massive, width of branch 15 to 25 mm. or more, peristomial tubes very short, each with a short blunt lip . . . . . . . . . *nigrescens.*
  Polypides, not black; plumes, six pairs.
    Width of branch (including peristomes) about 12 mm., peristomial tubes longer than their width, each with a short lip, no spines . . . . . . *levinseni.*
    Width of branch 5 to 10 mm., peristomial tubes short, spines long, slender, simple or forked . . . . . . *an undescribed species from the Cape Seas.*

## RELATIONS BETWEEN *RHABDOPLEURA* AND *CEPHALODISCUS*.

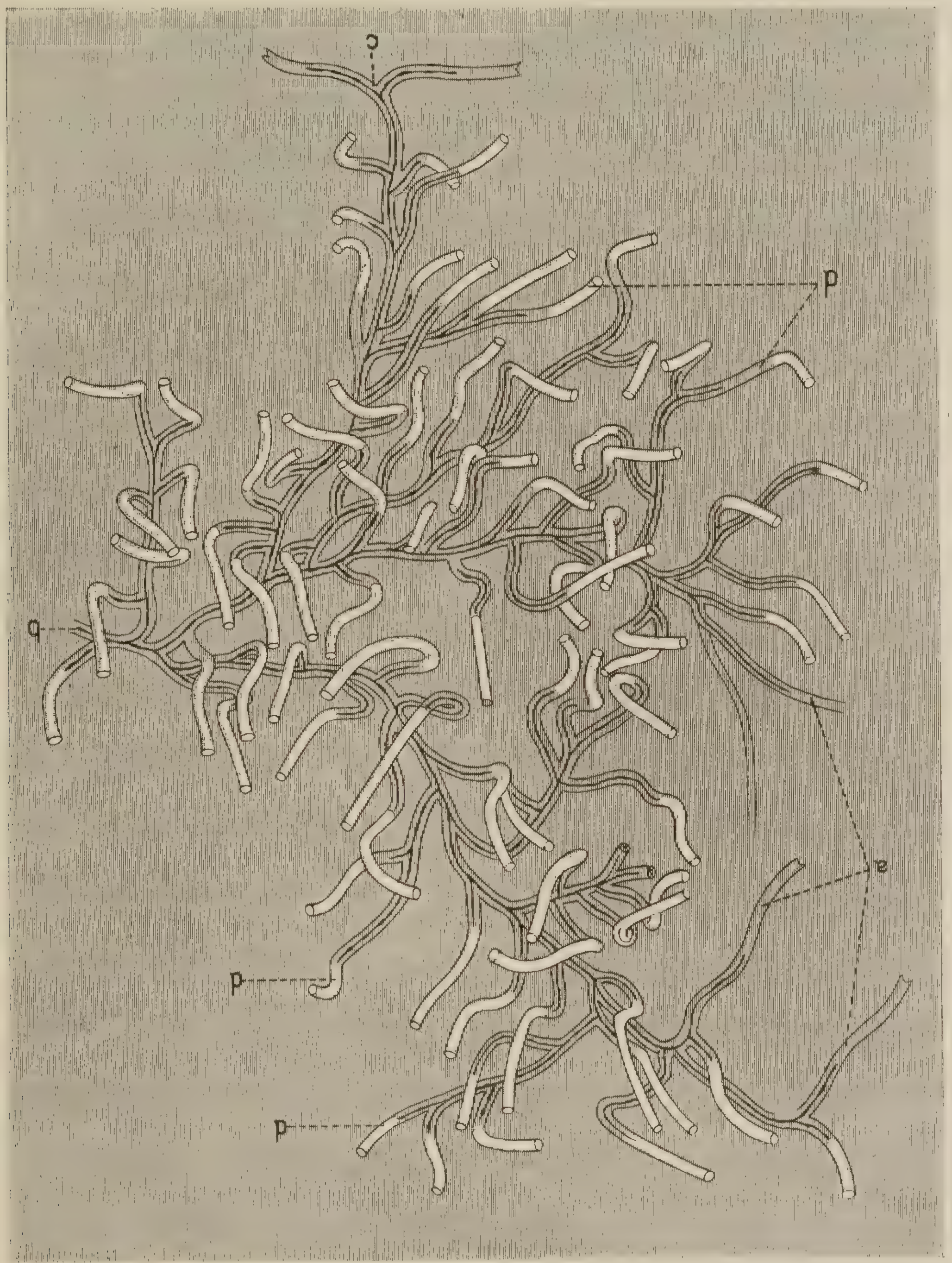
The discovery of species of *Cephalodiscus* with the polypides residing in separate tubular spaces in the tubarium (viz., *C. levinseni* and *C. nigrescens*) tends to show that *Cephalodiscus* is more closely related to *Rhabdopleura* than was supposed; although it must be borne in mind that the new tubes in the species of *Cephalodiscus* in question are formed independently of the older ones and not as laterally erupted branches of them (see text-fig. 6). In *Rhabdopleura*,* as in *C. levinseni* and *C. nigrescens*, the tube is lengthened by additions to its free edge, and, the increments being intermittent in both genera, the successive rings are distinct to the eye, although as a rule not readily separable by dissection. In instituting a comparison between the tubaria of *Rhabdopleura* and the above species of *Cephalodiscus*, however, it is to be noted that in the latter the rings are so broad, in a direction at right-angles to or oblique to the axis of the tube, as to form a tube-wall of considerable thickness, or even to constitute strata extending more than half-way towards the adjacent tubes, so that the space which in *Rhabdopleura* occurs between neighbouring tubes does not exist.

In *Rhabdopleura* each of the rings which compose the tube is in most cases interrupted by an oblique suture (text-fig. 7, B; see also Harmer, **10**, pp. 8 and 126). The polypide works round the periphery of the tube until it returns to its starting point; the part of the new ring that was first secreted having by this time hardened somewhat, the junction of the first-formed and last-formed parts of the ring is indicated by a suture. Possibly in some cases the secretion of the ring is so rapid that the suture is not discernible, while in other cases the polypide—usually an immature polypide with a bilobed buccal shield—forms only a half-ring at a time, so that the complete ring has two sutures (Lankester, **13**, p. 627).

In *Cephalodiscus levinseni* and *C. nigrescens* the rings that constitute the tubes are

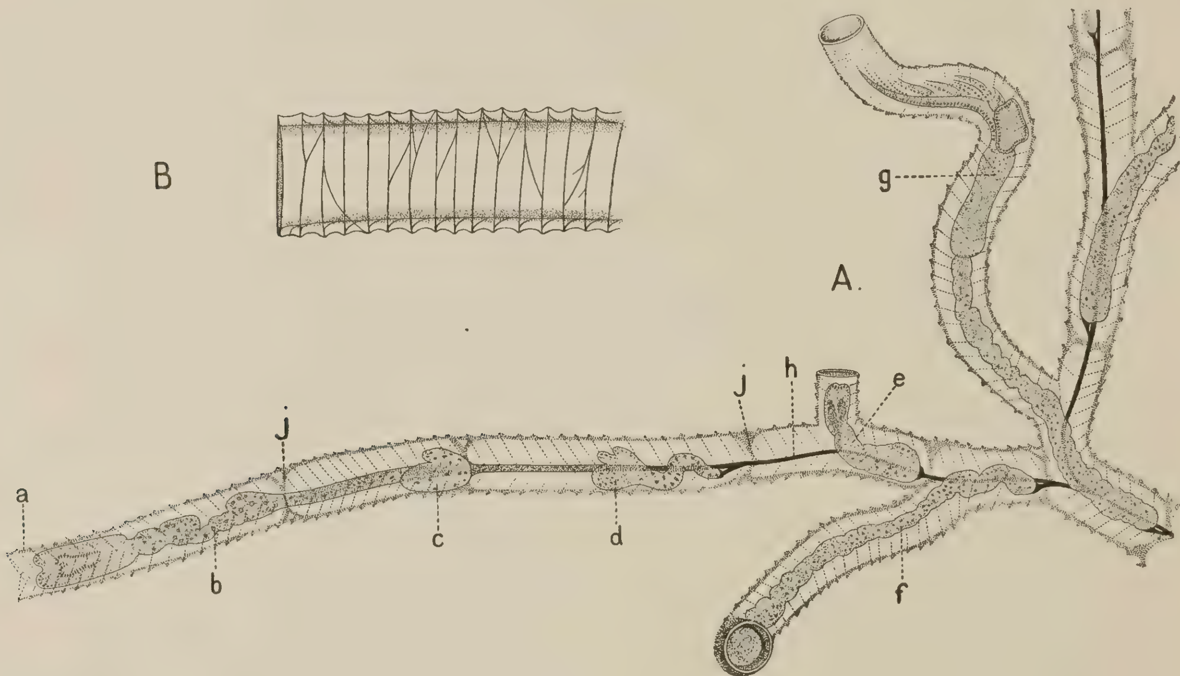
* In these remarks upon the structure and mode of growth of *Rhabdopleura*, Lankester's classical memoir (**13**) has been freely drawn upon, also papers by Allman (Quart. Journ. Micro. Sci., n.s. ix., 1869, pp. 57–63, pl. 8), Sars (Quart. Journ. Micro. Sci., n.s. xiv., 1874, pp. 23–24, one plate), Fowler (Festschr. 70ten Geburtstage R. Leuckarts, 1892, pp. 293–297, one plate; id. Proc. Roy. Soc., lii., 1893, p. 132; id. Quart. Journ. Micro. Sci., n.s. xlviii., 1904, pp. 23–31, one plate); Schepotieff (Bergens Mus. Aarbog, 1904, No. 2, pp. 1–21, three plates; id. Zool. Anz., xxviii., 1905, pp. 795–806, seven figures), and Harmer (**10**, pp. 125–128). An independent examination of *Rhabdopleura* was not made.

uneven, one portion being always more bulky than the rest. The lip of the tube owes its origin to this local profusion of the secretion. The rings are not necessarily complete, indeed half-rings, commencing at the lip and dying out at the other side of




TEXT-FIGURE 6.—*Rhabdopleura normani*, complete colony (× 3). (Copied from Lankester, **13**, plate 37 *bis*, fig. 2.) *a*, growing branches of the tubarium; *b*, the oldest portion of the colony; *c*, bifurcation of a growing branch; *d*, completed branches, each terminating in an upright polypide-tube.

the ostium, are common (Harmer, **10**, p. 9 and fig. 12). The disposition of these rings, complete and incomplete, is more clearly marked in *C. levinseni* than in *C. nigrescens*, for in the latter the common portion of the test that fills in the interval between one tube and the next ("external secondary lamellae" of Harmer) is more abundant, and only the terminal portions of the tubes stand out freely. The mode of deposition of the material in *C. nigrescens* is illustrated in figs. 12 and 13 of plate 4, and reference to the latter of these will show that not only may the secreted material spread over from the tube-margin to the interval between the tube in question and its neighbours, but that thin films are continued down the inner surface of the tube ("inner secondary lamellae" of Harmer). These secondary lamellae, both inter-tubular and intra-tubular, appear to have no existence in *Rhabdopleura*.




Text-Figure 7.—*Rhabdopleura normani*. A, — portion of a colony, highly magnified. (Copied from Lankester, **13**, plate 39, fig. 1.) B, — terminal portion of a tube, more highly magnified. (Copied from Harmer, **10**, plate 2, fig. 19.)

*a*, extremity of a growing branch; *b*, gymnocaulus or soft stalk of the terminal polypide of the growing branch; *c*, latest bud produced by the gymnocaulus; *d*, penultimate bud; the part of the stalk which produced it has now become hardened, and is known as pectocaulus; *e*, third bud; it has forced its way through the wall of the axial tubarium, and is constructing a lateral tube; *f*, fourth bud, counting from youngest; it is now a fully-formed polypide, with complete polypide-tube with recumbent and vertical portions; *g*, fifth bud; *h*, pectocaulus; *j*, *j*, septa of axial portion of tubarium.

The mode of bud-succession of *Rhabdopleura* is not paralleled in *Cephalodiscus*. The terminations of the branching colony of *Rhabdopleura* are, as Lankester has shown, of two kinds, those which are continuing to grow and produce buds (text-fig. 7, A, *a*), and those which stand out at right-angles to the general plane of the colony and are occupied by adult polypides (*f* and *g*). The proliferating stolon in the branches of the former kind has no hard covering such as is found on the organic stalk that

connects the full-grown polypides of the colony. It is called by Lankester (13) the "gymnocaulus," the hard stalk being termed the "pectocaulus." The gymnocaulus gives off a series of buds in regular succession (text-fig. 7, *g*, *f*, *e*, *d*, *c*) at the basal end of the terminal "proliferous polypide," which remains incompletely developed so long as it continues to produce buds from its stalk. Each bud remains in that part of the axial or growing part of the colony in which it was formed, and becomes partitioned off by the formation of a transverse septum (*j*), which stretches across the tube, and is traversed by the organic stalk of the colony, which shortly afterwards becomes hardened (pectocaulus, *h*). The bud, which has already developed a shield and a pair of plumes, now breaks through the side of the portion of the tube within which it is enclosed, and forms a lateral tube, commencing at the point of eruption, by the secretion of successive rings. It now enlarges and differentiates further, and becomes an adult polypide.

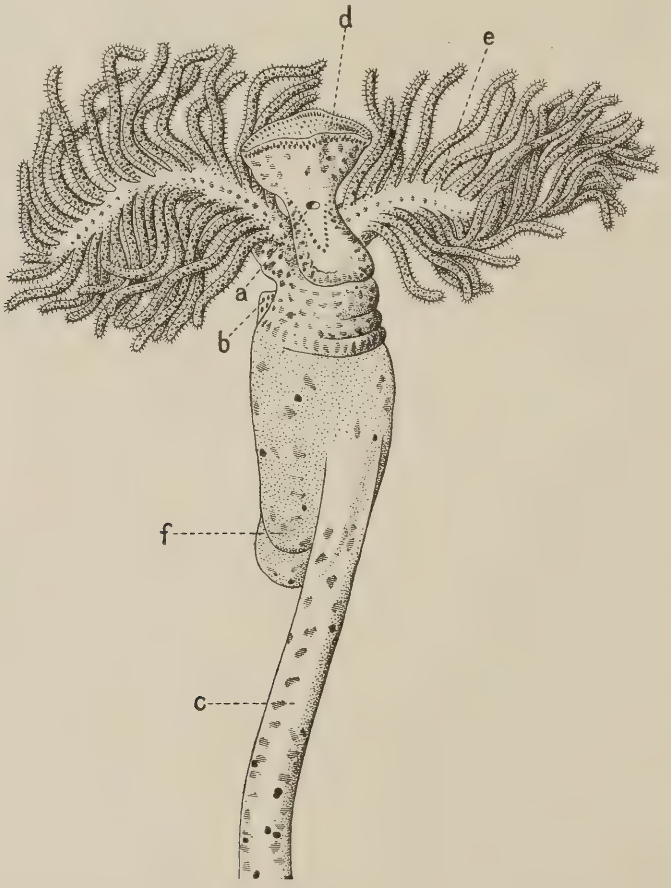
This succession of buds along the stalk of a terminal polypide of *Rhabdopleura* appears to have no direct equivalent in *Cephalodiscus*, and in *Cephalodiscus* there is no differentiation into ordinary polypides and proliferous polypides. All the polypides of *Cephalodiscus* seem to be capable of budding, the buds being formed around that area at the free end of the stolon where the severance of the polypide in question took place, when, as a full-grown bud, it separated from its parent polypide. Search was made for some such regularity of bud-succession as occurs in *Rhabdopleura*, but without success (see plate 7, figs. 69–84).

Returning to the consideration of the tubarium, it is to be noted that the tubes of *Cephalodiscus levinseni* and *C. nigrescens* do not arise as outgrowths from a main tube as do those of *Rhabdopleura*, but, so far as one can judge from a study of non-living material, each new cavity is from the first independent of other cavities (see plate 4, fig. 10). The newest tubes are the short ones at the apex. In other words, the bud of *C. nigrescens* separates off from its parent and forms an entirely new tube of its own, whereas the bud of *Rhabdopleura* breaks out laterally from the main or axial tube and remains in organic continuity with the parental stolon.

In the species of *Cephalodiscus* of the sub-genus *Demiothecia* (*i.e.*, *C. dodecalophus*, *C. hodgsoni*, *C. sibogae*, and *C. gracilis*) the polypides are more social than those of *Idiothecia*, and co-operate in the secretion of a common envelope, which may in a general way be described as an irregular branching tube with numerous ostia. The part played by the younger and the older polypides respectively in the building of the tubarium is not known, but most probably all polypides act in concert, and additions to the existing envelope are made by young and old indifferently.

As regards the general external appearance of the polypides, *Cephalodiscus* and *Rhabdopleura* have much in common—the division of the body into a buccal shield, a collar region with plumes, and a trunk region, larger than the others, and with a ventrally placed stalk (*cf.* text-fig. 8 and plate 6, fig. 49).

The red line of the shield which is so conspicuous and constant a feature of *Cephalodiscus* does not seem to be present in *Rhabdopleura.* Schepotieff shows, in the exact position occupied by the red line in *Cephalodiscus*, a "Pigmentstreif" (1904, pl. 2, fig. 9, and 1905, p. 796, fig. 1), but since he says nothing about red colour, one is led to conclude that the pigment-stripe is black. The crowd of black pigment spots at the anterior point of the shield of *Rhabdopleura*, assumed to be a rudimentary organ of vision, finds no equivalent in *Cephalodiscus.* The relations of the shield to the mouth, however, and the great mobility of the shield, and the glandular nature of




Text-Figure 8.—*Rhabdopleura normani*, a polypide greatly enlarged. (Copied from Lankester, **13**, plate 38, fig. 1.)
*a*, mouth; *b*, anus; *c*, polypide stalk; *d*, buccal shield; *e*, plume; *f*, visceral mass.

the thick central part of the ventral wall of the shield (Schepotieff, 1905), are the same in both *Rhabdopleura* and *Cephalodiscus.*

The collar region is produced in both into a postoral lamella and plumes. The latter are two in number in *Rhabdopleura*, and although *Cephalodiscus* has in most cases four pairs or more, Harmer's discovery of male polypides of *C. sibogae* with one pair of plumes only (**10**, p. 84) is of interest in this connection, in spite of the fact that such plumes do not possess pinnules.

The mode of development of the plumes of *Rhabdopleura* from the dorsal region of the collar near the stalk of the buccal shield, and the mode of development of pinnules upon them (see Lankester, **13**, pl. 39, fig. 3, buds 5 and 6, and the slightly older bud figured below these ; also Allman, 1869, pl. 8, figs. 7 and 8, and Schepotieff, 1905, p. 802, fig. 6) renders it almost certain that these two plumes are the equivalents of the first pair of plumes that develop upon the bud of *Cephalodiscus*, and not of the short lophophoral arm which in *Cephalodiscus dodecalophus* bears the six plumes of its own side of the body. The second and later pairs of plumes of *Cephalodiscus* are not represented in *Rhabdopleura*. The pinnules of *Rhabdopleura* are equivalent to the pinnules of *Cephalodiscus*.

On each plume of *Rhabdopleura* are about fifty pinnules, projecting ventrally from the two edges of a ciliated groove, which has a central ridge. In his earlier paper (1904, p. 12) Schepotieff was inclined to regard this central ridge as bearing a third row of pinnules, but since he says nothing of these in his later paper (1905, p. 797) he has presumably withdrawn that view. The plumes and their pinnules are hollow, and are lined by a tough sheet of skeletal connective tissue, which remains when the epithelium disintegrates, and gives a false impression of being solid; hence the erroneous statement of Sars that the skeleton of these parts is cartilaginous.

The postoral lamella resembles that of *Cephalodiscus* in that it consists of a pair of lateral flaps (" Seitenlippen " of Schepotieff), containing continuations of the collar coelom, the middle part, posterior to the mouth, being, however, less free than in *Cephalodiscus*. *Rhabdopleura* has a front lip, distinct from the postoral lamella.

Although gill-slits do not exist in *Rhabdopleura*, the position which these would occupy is clearly indicated by a pair of ciliated grooves (" Kiemenrinnen " of Schepotieff, 1904, pp. 13 and 14, and 1905, p. 796 and fig. 5). These grooves are clearly the equivalents of the pair of triple grooves of *Cephalodiscus* which Masterman has described as conducting the food particles from the plumes into the mouth. In *Cephalodiscus* there are a pair of perforations of the pharyngeal wall which serve the purpose of disposing of the excess of water that has come down the grooves charged with the food organisms. Such perforations are wanting in *Rhabdopleura*. Schepotieff's Kiemenrinne is a continuation of the ciliated groove on the ventral side of the plume-axis; it passes from the plume-base down the side of the collar region and the stalk of the shield, and runs down the side of the mouth into the first portion of the alimentary canal, where its walls change in character. At the side of the mouth the cells composing the wall of the groove are tall, columnar, ciliated cells; those in the pharyngeal region are pale-staining cells, partially vacuolated, and sharply delimited from the other cells of the pharyngeal wall—they constitute the " pleurochords " (Schepotieff, 1905, fig. 5). It is where the groove changes in character, *i.e.*, at the anterior end of the pleurochord, that one would look for the gill-slit.

The alimentary canal of *Rhabdopleura* resembles that of *Cephalodiscus* in the position of the mouth and anus, the flexure of the gut, and the presence of pleurochords and notochord; even the gastric caecum of *Cephalodiscus* is represented ("Blinddarm" of Schepotieff, 1904, p. 14).

The notochord (Fowler and Schepotieff) is an anteriorly directed diverticulum of the first part of the alimentary canal. It is usually solid, but in some polypides possesses a cavity. The cells of the hinder or basal part are frequently vacuolated and resemble those of the Eicheldarm of *Balanoglossus*; in the terminal portion is a "cartilaginous" or "gelatinoid" substance ("Stützkörper" of Schepotieff, 1905, p. 800) which stains very darkly with haematoxylin. The notochord lies in the region where the median septum of the dorsal part of the collar meets the septum that divides the collar cavities from the proboscis cavity.

The central nerve mass of *Rhabdopleura* (Fowler and Schepotieff) lies, as in *Cephalodiscus*, on the dorsal side of the neck region. It is situated between the plume-bases, the collar pores, and the anal papilla. The superficial epidermal cells that cover it are pigmented, and, according to Schepotieff, constitute a sense organ.

On the evidence of Fowler and Schepotieff the divisions of the coelom are exactly as in *Cephalodiscus*, namely, a proboscis cavity in the buccal shield, a pair of collar cavities and a pair of cavities in the trunk region. The pericardium, on the authority of Schepotieff, constitutes a sixth cavity (*vide postea*). The cavity in the buccal shield is shut off from the collar coelom by a septum, and from this septum there pass muscle fibres to the thickened ventral wall of the shield. The cavity opens to the exterior by a pair of pores, the proboscis pores (Schepotieff, 1905, pp. 797 and 798, and fig. 2, *Ksp.*). Situated in the proboscis cavity, and set close against the septum, is the pericardium, within which is the heart, in contact with the ventral surface of the notochord (Schepotieff, p. 799, and fig. 4; *cf.* text-fig. 12 of this paper).

The right and left collar cavities are separated by a median septum dorsally to the notochord, and are continued laterally into the flaps of the postoral lamella, and forwards into the plumes and pinnules. In his earlier paper (1904, p. 16) Schepotieff states that the plume cavity is separate from the collar cavity, but in the later one (1905, p. 799) he regards the two as continuous. Each collar cavity opens to the exterior by a collar canal, with a wide internal opening and a narrow collar pore. While the collar pores of *Cephalodiscus* are strictly lateral, and far back, near the gill-slit, they occur dorsally or dorso-laterally in *Rhabdopleura,* on the plume-bases, on the right and left sides of the central nerve mass. Schepotieff represents the collar pores close to the anus, whereas Fowler identifies the positions of the collar pores with those of the ciliated tubercles of Sars, which in the earlier figures (Sars and Lankester) are represented as at some distance in advance of the anus. The difference is probably to be accounted for by the relative state of contraction or extension of the polypide: in a well-extended polypide the lengthening of the neck

or collar region would have the effect of removing the central nerve mass and the collar pores from the anal region. Both collar canals and proboscis canals are regarded by Schepotieff as "nephridia" (1905, p. 801).

The trunk coelom does not open to the exterior. It is continued into the stalk, as was first noticed by Lankester, and it is divided by a median septum, which runs into the stalk, dividing it into right and left parts more completely than does the corresponding septum in *Cephalodiscus*. The longitudinal muscles of the stalk, says Harmer (**10**, p. 78) are related to those of the body exactly as in *Cephalodiscus*, and there are two blood-vessels. The posterior of these, according to Fowler (1904), is continuous with the lining of the alimentary canal; but Harmer is inclined to doubt this, and to regard it as a true blood-vessel, homologous with the posterior blood-vessel of the stalk of *Cephalodiscus*. There is a nerve tract on the anterior or ventral side of the stalk, exactly as in *Cephalodiscus* (Fowler, 1904).

The gonads of *Rhabdopleura* are not well known, owing to the fact that most of the material examined has been collected at the wrong time of the year. The only definite information on the subject is that given by Lankester (**13**) and Schepotieff (1905, p. 801), according to whom the testis is unpaired, and situated on the right side. It is a long sac, which extends from the posterior end of the visceral mass to the anal papilla, and the hinder part is sometimes swollen, and contains developing spermatozoa, whereas the rest of the sac is filled with ripe spermatozoa. The ovary of *Rhabdopleura* may be said to be unknown, since the account of the ovary and testis as occurring in different parts of the peduncle, given by Conte and Vaney (C. R. Acad. Sci., 1902, p. 64) is too brief to be intelligible.*

In describing the growth of the bud of *Rhabdopleura* Schepotieff notices (1905, p. 803) that the coelom is divided into six parts at an early stage, two in the shield, two in the collar, and two in the trunk, the last continuous for some time with that of the parent stolon. The right half of the shield cavity is much smaller than the left; it becomes median, and after undergoing further reduction in size, persists as the pericardium. The gut develops as a solid mass of cells, subsequently hollowed. The notochord develops from the anterior part of this, and the stomodaeum opens into the middle part. The proctodaeum is a solid mass of ectodermal cells, hollowing later, and becoming connected with the hind end of the primitive gut. Fowler, it is to be noted (1904, p. 28), regards the notochord as developed from the stomodaeum, and not from the primitive gut.

In reviewing the above remarks on the polypides of *Rhabdopleura*, it will be seen that in bodily structure *Rhabdopleura* agrees very closely with *Cephalodiscus*, the only important differences being in the position of the collar pores, the number of the plumes, and the absence of pharyngeal perforations or gill-slits. The

* These authors are also responsible for a denial of the existence of collar pores, and divisions of the coelom, and the presence of a notochord, the structure recognised as notochord by Fowler (1892) being, according to them, nothing more than the anterior end of the peduncle. Fowler's observations, it is well to bear in mind, have since been amply confirmed by Schepotieff (1904 and 1905).

persistence of the branching stolon in *Rhabdopleura*, so that the polypides remain in organic continuity, constitutes another point of difference, and the frailness of the tubarium and the diminutive size * of the polypides and colony, yet other differences; but on the whole the effect of recent investigations made upon *Rhabdopleura* and *Cephalodiscus* is to justify the action of the earlier zoologists in associating these two genera in the same group—Pterobranchia of Lankester, Aspidophora of Allman, Discophora of Hatschek.

## DESCRIPTION OF *CEPHALODISCUS NIGRESCENS.*

*Cephalodiscus nigrescens*—Lankester, Proc. Roy. Soc., 1905, pp. 400–402.

### *Material.*

The whole of the material of this species at present known was dredged by the 'Discovery' on January 13th, 1902, in 100 fathoms, off Coulman Island near Victoria Land, in the Antarctic Ocean. The bulk of it was preserved in a 5 per cent. solution of formalin, but two pieces were fixed by Perenyi's fluid, followed by alcohol, and two pieces by picric acid solution, followed by alcohol.

### *Tubarium.*

The colony of this species is bulky and massive, the tubarium † gelatinous in appearance, nearly transparent, somewhat opalescent, and with a slight yellowish-brown tint. The largest piece in the collection measures roughly 190 mm. by 115 mm., and has twelve branches (15, also plate 1 of this Report). A smaller but more massive piece is shown in fig. 2, plate 2. The largest single branch is 90 mm. long and 32 mm. across. The branches are roughly cylindrical in shape; the larger ones are blunt-ended, the smaller ones taper towards their extremities.

Opening at fairly regular intervals over the surface of the colony are the tubes in which the polypides dwell, and the substance of the tubarium is sufficiently transparent to enable one to trace the tubes inwards for a moderate distance with the unaided eye, and to recognise the polypides within the tubes. The lining of the tube, *i.e.* the layer which bounds the cavity in which the animal lives, is darker in tint, and of tougher and firmer consistency than the common portion

* Fowler puts the diameter of the polypide of *Rhabdopleura* at ·123 mm., and Schepotieff at ·15 to ·16 mm.

† The soft secreted material that forms the protective envelope or dwelling of *Cephalodiscus* has almost invariably been called the "coenoecium," a term which was shown by Lankester as far back as 1884 (13, p. 624) to be inappropriate, for the coenoecium of the Polyzoa is the locally thickened cuticle of the hinder part of the polypide's body, to which it is permanently adherent. In describing the structure of *Rhabdopleura*, Lankester explains (13, p. 635) that it is the caulotheca or stalk-pipe of this animal which is the true homologue of the coenoecium of the ordinary Polyzoon colony. "This equivalence," he continues, "makes it all the more necessary to distinguish the tubular dwelling of *Rhabdopleura* by some other name, and justifies the special term 'tubarium.' The tubarium has no equivalent in Phylactolaemous and Gymnolaemous Polyzoa."

of the tubarium in which the tubes are embedded. The two substances are doubtless of a similar nature, but in consequence of the above differences it will be convenient in the following pages to refer to them as the "tube" and the "test" respectively.

The edge of the mouth of each tube is produced into a blunt lip, and the roughness of the surface of the colony is due mainly to these projecting lips. In some portions of the colony the tubes, not merely their lips, project beyond the general surface, even to the extent of 4 mm., as though there had been a deficiency in the production of the common test between the tubes. The lower part of each tube, *i.e.* the part farthest from the external aperture, is unoccupied, and extends obliquely towards the axis of the branch (see fig. 4, plate 3, and fig. 10, plate 4).

A transverse section of one of the branches of the colony (fig. 6) shows around its edge the lips and distal portions of the tubes, with some of the animals within them; the central part shows the empty deeper parts of tubes which open nearer to the extremity of the branch than the level of section.

In the middle of the length of a branch of a colony of average size the tubes have a length of 12 to 17 mm. Their width is nearly uniform throughout (1·2 or 1·3 mm), but near the external opening the cavity becomes very slightly wider, and the end of the tube remote from the external opening is usually enlarged into a kind of bulb, with a slightly narrowed neck. This end is closed and blind (fig. 11). There is nowhere in the colony any sign of branching of the tubes, nor of the communication of one tube with another.

The blind end of the tube has a variable number of thin septa, mostly hemispherical, but occasionally irregular. These one may reasonably suppose to have been secreted successively, the last-formed one of the series being that which is nearest to the polypide, or rather its buds, for these are found towards the blind end of the tube (fig. 11).

If a tube of the colony be dissected from its neighbours by cutting away the common test that surrounds it, and a longitudinal section be taken, the mode of lengthening of the tube by additions to its margin, and the mode of increase of the common test by the deposition of successive strata between the tubes at once becomes apparent (see figs. 11 and 12). The layers added to the rim of the tube by the polypide are continued down the interior of the tube for some distance as very thin sheets, of darker colour than usual. The terminal portion of the tube is slightly wider than lower down, and these thin sheets have the effect of diminishing the width, so that when the part under consideration is no longer terminal it is no longer wider than the average of the tube.

The softer common test between the tubes has a stratification which is more intimately related to the general surface of the branch than to the tubes. How these layers of the test are deposited by the polypides it is difficult to understand,

except one admits that the polypides are capable of leaving their tubes and wandering over the surface.

The apex of each branch of the colony is bluntly pointed, and the terminal eight or ten tubes have transversely terminated ends without unilateral lips, slightly projecting above the general surface (fig. 10). These tubes have a length of not more than 4 or 5 mm., but their width is the same as that of the longer tubes situated lower down. They are curved or bent, sometimes bent as much as a right-angle, and they are closely crowded. Judging from the appearance of the more basal parts of the branch, it would seem that the bent portions of the tubes are subsequently straightened out, and that the tubes themselves become more widely separated from one another, either by deposition of new intervening common test, or by expansion of that already existing, though how this can be effected it is difficult to conceive. The short bent tubes of the apex of the branch have a bulbous swelling, not smaller than those of the longer tubes, but they differ from the latter in having no hemispherical septa within them.

In exceptionally thick pieces of the colony, e.g. a piece of 30 mm. diameter, the tubes are very much longer than usual, and may attain a total length of 20 to 26 mm. These very long tubes are mostly empty tubes, and the septa are much more numerous than usual, and extend over 9 to 12 mm. of the tube. The part of the tube occupied by the polypide up to the time of its vacating the tube is thus 11 to 14 mm. in length. Some of the long, uninhabited tubes have the apertures closed, and a longitudinal section of the tube shows that the closing has been effected by the deposition, first of some five or six thin sheets, irregular and widely separated, in the mouth of the tube itself, and then several thin layers of test over the opening, the stratification of these layers bearing no relation to that of the layers of which the tube is constructed (see fig. 13). The "burying layers" are not continued over the lip of the tube.

In what one may conclude to be the upright branches of the colony the tubes are set at the same angle to the axis on all sides, and the lips are all beneath the apertures of the tubes; in the horizontal and oblique branches, however, it is only on the lower surface that the lips are strictly towards those edges of the apertures which are nearest the base of the branch. The openings are few on this surface, most of the tubes having curved round so as to open at the sides of the branch.

At the sides of such a branch the lips are so situated as to be vertically below the apertures of the tubes, and they are thus lateral as regards the tubes themselves in their relation to the whole branch. The apertures on the upper surface of the horizontal branch are arranged irregularly, and the terminal portion of each tube is set nearly at right angles to the surface of the branch. The lips of the tubes are mainly towards the edges which are nearest the base of the branch, but the relation is not constant. Further complication is introduced by the presence of the secondary

branches. These arise mainly from this upper surface, and where a young branch is being developed the apertures of those tubes on the relatively main branch that lie close around it are symmetrically disposed around its base, and have the lips on the edges of the tubes most remote from the axis of the new branch.

The above generalisation holds good in the main, but in places one meets with a most irregular disposition of the apertures of the tubes, and a pair of tubes opening to the exterior within 10 mm. of one another may have their apertures facing one another, and yet have no trace of a developing branch between them.

A secondary branch behaves in its development as a foreign organism. The polypides of the new branch, having begun to secrete their tubes at some small area of the surface, incommode the polypides of the main branch in their immediate vicinity, and cause them to distort their tubes so that the openings are well outside the area settled upon. If a young branch be roughly handled, it breaks off and leaves an irregular flat or concave scar composed of soft test only, none of the tubes of the secondary branch running into the main branch (fig. 5, *a* and *b*, plate 3). Should any deserted tubes of the main branch open within the area upon which a new branch is growing, it is covered over with common test, and, unlike the inhabited tubes, is found in the scar (fig. 5, *c*).

In a young branch there is a marked contrast between the new tubes of its base and the old tubes of the main branch opening around its base. The old tubes have longer, thicker, and browner lips. The common test of a young branch resembles that of the apex of an old branch in being softer than usual, paler, and more transparent, and in being composed of thicker strata.

Until this species of *Cephalodiscus* shall have been studied in the living state it will be impossible to make any definite statement with regard to the mode of growth of the colony, but so far as one can judge from the material available, the deductions are as follows :—the fully-grown buds, after severing their connection from the parent stolon, emerge from the tube within which they have been growing, and wander over the surface of the branch. They are gregarious, and eight or ten of them collect either at the apex of the branch, or, in the case of an old branch, settle in a patch at some convenient spot on the surface and start producing a new branch. They secrete profusely a soft investment common to them all, within with each lives in a sharply bent or curved tubular cavity with a bulbous blind end. By the addition of numerous thin layers to the interior of the neck of the bulb the "tube" becomes differentiated from the "test." These lining layers are continuous with the margin of the tube, where they are comparatively thick layers and resemble so many superimposed rings. The mouth of the tube projects slightly above the general test, and has no lip.

As younger polypides than these migrate to the apex of the new branch and secrete profusely, the polypides under consideration lengthen their tubes in an obliquely radial direction in order to avoid being covered in—incidentally developing

a "lip" to the margin of each tube—and as apical growth continues and they themselves come to occupy positions successively more remote from the apex, they make their tubes longer and longer by additions to the margin, and they fill in the spaces between the tubes with softer common test, so that the part of the branch in which they occur becomes thicker and thicker. Since, apparently, this makes the tubes uncomfortably long, a shortening of them is effected by the successive formation of concave septa at the basal ends at such a rate as to leave the inhabited part of each tube about 8 or 12 mm. in length.*

### *Polypides.*

The polypides are deeply pigmented and show conspicuously through the test. Most of them are in a state of contraction, and their plumed ends are situated about 5 mm. from the openings of the tubes in which they dwell; a few, however, are moderately expanded, and the plumes of these project slightly beyond the openings of the tubes. Not more than one fully-grown polypide is found in each tube, but from two to nine buds of various sizes are connected by their stalks with the end of the stolon of the individual to which the tube may be said to belong. The buds are usually crowded at that extremity of the polypide which is farthest from the opening of the tube. Lying freely in the tube in the vicinity of the buds an ovum sometimes occurs, rarely two or three; the ovum is oval and yellowish-white, and measures ·5 by ·6 mm. or ·6 by ·7 mm. The ova are seen in figs. 3 and 4 as small whitish oval patches.

The polypide is about three times as long as that of *Cephalodiscus dodecalophus.* The length of the body from the front of the buccal shield to the end of the visceral mass is 4·5 mm., whereas in *C. dodecalophus* the corresponding measurement is 1·5 mm. The body is about 1 mm. wide, and fits fairly closely in the tube, the interior of which is not more than 1·2 or 1·3 mm. across.

When removed from its tube, a polypide and its buds present the appearance shown in fig. 7, plate 3. The buds are contracted and have their stalks twisted about one another in a manner which is obviously unnatural and is doubtless caused by the irritation set up by the fluid in which they were killed. With a little care the stalks of the buds of the formalin-preserved material can be unravelled (fig. 8); the material fixed in Perenyi's fluid and that fixed in picric acid solution is, however, too brittle to allow of any disentangling of the stalks.

* The above was written before the publication of Harmer's report on the Pterobranchia of the 'Siboga' Expedition, and it is interesting to note that in one of the new species described by him (*C. levinseni*) the polypides are similarly isolated, each tube of the tubarium being occupied by one polypide and its buds, and that the explanation of the growth of the colony which he puts forward (**10**, p. 11), includes as its essential feature the migration of the buds from the parental tubes, their crawling over the surface of the colony, and their subsequently establishing themselves in a suitable situation upon the surface, where they secrete tubes of their own. (Later note, dated Sept. 15, 1906:—The manuscript of the descriptions of *C. nigrescens* and *C. hodgsoni* (pp. 20–62 of this Report) was completed in August 1905; the first nineteen pages of the Report were written in the summer of 1906).

The pigmentation * of the skin is deep over the visceral mass (figs. 7 and 8), less deep over the gonads and along the ventral surface of the stolon, which touches the interior of the tube, and over the part of the surface of the body between the buccal shield and the stolon. The axes of the plumes have a double black band running along them, the two bands converging towards the tip, which is entirely black. There is a black edge to the buccal shield. Near the posterior † edge of the buccal shield is a curved line of brilliant red, and a similar red pigment is seen in the oviducts.

The blackish colour of the body is due to a superficial layer of large cells, which are brown in colour when mounted in glycerine and examined under the microscope (see fig. 9, plate 3); they do not stain with haematoxylin or borax-carmine solution, they seem to have no nuclei, and they contain each one small spherical pigment granule, sometimes two. In very thin sections each cell appears to be composed of thirty or forty closely packed polyhedral grains of a dark straw or a raw sienna colour. This is the appearance presented in sections or teased preparations made from the material fixed in formalin, or in Perenyi's fluid. In that fixed in picric acid solution the pigment cells are considerably swollen and are not brown in colour, but each cell shows its one or two small black spheres, as in the other material. Pigmented cells similar to those of the epidermis occur in the wall of the pharynx and in the pleurochords, either as solitary cells or in small groups.

At intervals in the sections of the pigmented epithelium are seen masses which stain deeply, each about as large as one of the pigmented cells. In carmine-stained sections these are uniform in tint, but in those stained with haematoxylin they appear finely granular. They are presumably the secreting cells of the epidermis. They show no nuclei, and there is no distinction between the cytoplasm and the deeply-staining mass, which latter I take to be the secreted material not yet emitted. These cells occur in all parts of the superficial layer, over the body,

* The species now under consideration was termed *C. nigrescens* (**15**) before the publication of the 'Siboga' Report on the Pterobranchia. In that Report Harmer notes that the epidermis of all parts of the body of *C. sibogae* is pigmented (**10**, pp. 8 and 49). He also states that a median line of pigment occurs on the anterior side of the stolon of *C. gracilis* (p. 52), and that deserted stolons of individuals of this species are deeply pigmented (p. 93).

† The usual orientation of the body is accepted in this communication; the plumed end of the body is regarded as the anterior end, and the surface of the body upon which the mouth opens, and from which the stolon arises, as the ventral surface. Harmer, in his most recent work on the subject (**10**, p. 23), adopts a new orientation, taking the main axis of the body as passing from the middle of the buccal shield through the central nerve mass, and ending on the rectal side of the body a little below the anus, so that the visceral mass is regarded as a ventral downgrowth. He denies that in the bud the elongating caecal end of the intestine leaves its position in the part of the "body" near the stalk and migrates along the aboral surface of the pharynx, subsequently opening to the exterior in the position in which the anus is found in the adult, and suggests (**10**, p. 100, par. 3) a lateral pinching-in which separates a dorsal intestine from a ventral stomach, with formation of a median mesentery between. One objection to the acceptance of Harmer's orientation is that in the adults of *C. nigrescens* the notochord is a long structure lying parallel with the thick face of the shield, and more or less in a line with the pharyngeal axis (text-fig. 10, p. 34), and it is not unreasonable to regard this as determining the median axis of the polypide. For practical purposes the earlier terminology is preferable.

on the plume-axes and on the pinnules, but they occur in greatest abundance in the dorsal layer of the buccal shield.

The red colour of the curved line of the buccal shield and that occurring in the oviducts is due to closely crowded granular cells of small size, of uniform character, and of a bright red colour which remains, or, at most, has turned to a reddish brown, in sections cut by the paraffin method. In the material fixed by picric acid solution the cells are not swollen, but present the same appearance as in that fixed by formalin or by Perenyi's fluid.

Except in the case of a small number of polypides found loose at the bottom of the bottles—specimens which had clearly escaped from their tubes at the moment of immersion of the colony in the preservative fluid (fig. 14, plate 4)—and in polypides taken from the terminal tubes of the colony (fig. 15), the stolon does not stand out obliquely or hang ventrally as it does in *Cephalodiscus dodecalophus*, but it runs back parallel with the long axis of the body (figs. 7 and 8, plate 3). On an average of cases it leaves the body midway between the hind edge of the buccal shield and the end of the visceral mass. It is short, stout, and transversely wrinkled: in much contracted specimens the visceral mass partially envelopes the stolon, a concavo-convex flap of it lying against one or both sides of the stolon. On the other hand, in the above-mentioned individuals which appear to have died free, and uninfluenced by the limitations imposed by the tubes (fig. 14), the visceral mass is not distorted by the stolon, and, further, it has a general curvature towards the ventral side of the body.

There is a striking uniformity in the general appearance of the fully-grown individuals. Full-grown polypides that have not two or more buds and a pair of gonads in mature condition are not met with, and the regular presence of ripe gonads in individuals which are actively budding is not the least remarkable feature of *Cephalodiscus*. Further, although large ova are frequently encountered lying loose and singly in the blind ends of the tubes of the colony, they appear to be all of the same age, and exhibit no signs of segmentation.

A polypide remains as a bud until its plumes are almost of full size, and until itself is nearly as large as the individual to the end of whose stolon it is attached. Such a "ripe" bud usually carries at its point of contact with the main stolon a very small bud of its own, and it has gonads about one-fourth or one-third of the normal size.

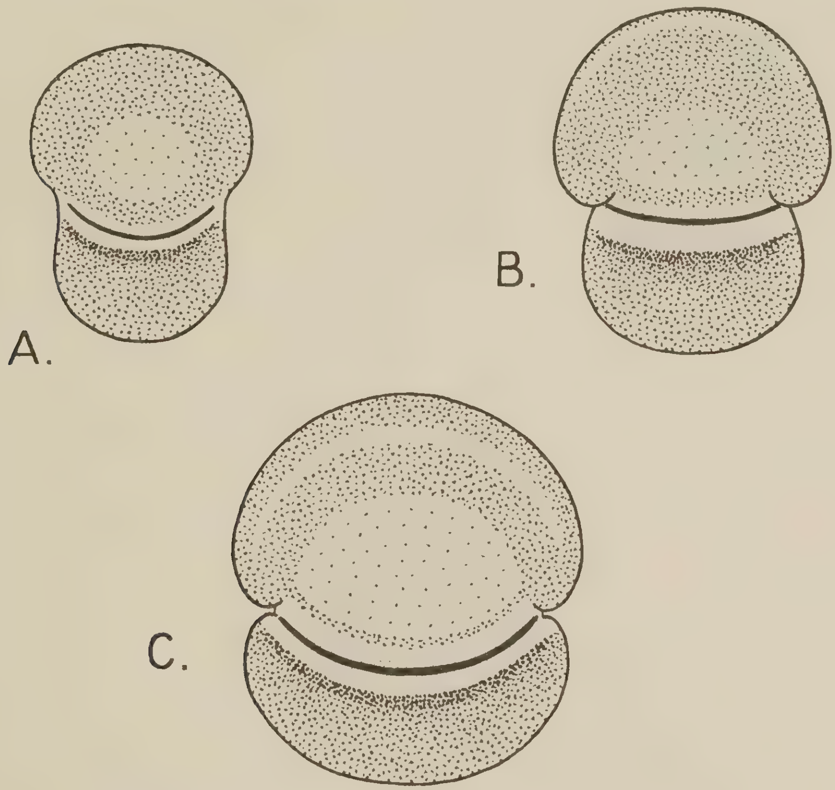
Although throughout the colony, and not merely at the apices, the polypides are producing buds, it is only at the tips of the branches that one meets with what may be regarded as newly established polypides. A polypide from one of the terminal tubes of a branch of the colony differs from ordinary polypides, in that there are no gonads recognisable by dissection,* the visceral mass is more swollen

* This is odd, in view of the fact that small gonads can be recognised in ripe buds not yet separated from the parent stolon.

at its extremity, and the stolon is attached relatively farther from this end of the body and nearer to the buccal shield (fig. 15, plate 4). The end of the stolon bears from two to five buds of various sizes, and thus resembles that of ordinary polypides.

### *Buccal Shield.*

The outline of the buccal shield is that of an oval with indented sides (text-fig. 9, C). The ventral surface is not flat, but has a raised central portion separated from the anterior and posterior portions of the rim by shallow grooves.




TEXT-FIGURE 9.—A = Buccal shield of a bud of *C. nigrescens* with two pairs of plume-axes only; B = Shield of a bud with four pairs of plume-axes; C = Shield of adult polypide of *C. nigrescens*. The figures are drawn to the same scale of magnification (× 43).

The anterior and posterior borders are deeply pigmented, and slightly in advance of the inner dark border of the posterior part of the shield, but separated from it by a pale band, is a well-defined red line, which is curved, and follows the posterior half of the outline of the central and thicker portion of the shield. In text-figure 9 the red line is represented by the firm black line that passes across the shield (see also plate 3, fig. 8, *b.s.*).

In a well-expanded shield, removed and mounted for examination under the microscope, the antero-posterior diameter is slightly greater than the maximum width, and the distance from the centre of the red line to the anterior edge of the

shield is about $2\frac{1}{2}$ or $2\frac{3}{4}$ times the distance from the red line to the posterior edge (text-fig. 9, C). The average measurements taken from a number of well-expanded shields are as follows:—

| | |
|---|---|
| Centre of red line to front edge of shield . . | ·89 mm. |
| Centre of red line to hind edge of shield . . | ·34 mm. |
| Total antero-posterior diameter . . . . . | 1·23 mm. |
| Maximum width of shield . . . . . . | 1· 1 mm. |

The shield is attached to the body by its middle part only, and tears off readily. The tearing away of the shield lays bare a pair of fairly large holes, situated in front of the mouth and behind the bases of the plumes, and leading into the two collar cavities. The cavity of the shield (proboscis cavity) has the form of a cleft between the two layers of the shield, and is traversed by muscle fibres and connective tissue strands which have prominent nuclei along their course. The cavity opens dorsally among the bases of the plumes by a pair of small canals (proboscis pores) situated to the right and left sides of the pericardium.

The middle part of the ventral face of the buccal shield is thick and firm, and stains with borax carmine more deeply than any other part of the body. A few scattered yellow-brown cells may be found in this part, but they are not crowded as they are at the edges of the shield. The outer face of the buccal shield is ciliated, but not the dorsal surface.

The red line that is so conspicuous a feature in the buccal shield owes its existence to crowded granular cells of uniform character and bright red colour. The mass of red cells extends through the whole thickness of the ventral layer of the shield (text-fig. 10, *r.l.*, p. 34), and the red line shows equally well on this face of the shield and on that face (dorsal) against which the mouth opens, for the cavity of the shield is but a narrow cleft in the region of the red line, and the oral layer of the shield is thin and transparent.

The buccal shield is clearly an extremely mobile structure, a conclusion arrived at not merely by analogy with that of *Rhabdopleura* (which has been studied in the living state), but from the various positions in which the shield may be found in the adults, and more particularly in the buds, of the species of *Cephalodiscus* now under consideration. It is no unusual thing to find the buccal shield of an adult twisted on its stalk through 90 degrees, so that the anterior and posterior edges are right and left, and the curved red line is antero-posteriorly placed instead of being transverse to the length of the body. In half-grown buds the posterior lobe of the buccal shield is frequently bent outward at a right-angle or even at a smaller angle to the rest of the shield (see fig. 65, plate 7). In both buds and full-grown polypides the posterior lobe of the shield is thinner than the anterior lobe. In buds the shield is relatively narrower than in the adult (see text-fig. 9, A and B, and pp. 47–48).

### *Post-oral Lamella.*

The post-oral lamella consists of a pair of flaps projecting laterally from the right and left sides of the mouth. The flaps are continuous with one another behind the mouth aperture, but the connecting part is very narrow. The lateral flaps are mostly wrinkled at their edges in a manner which suggests that they are now in a partially contracted state, and would in the living animal be of greater extent. They may cover the collar pores and gill-clefts, but much depends on the degree of contraction of the individual examined; their probable function is to direct the food-current into the mouth and to separate it from the current that is issuing from the gill slit. The food-current coming down the grooves on the outer sides of the plumes probably passes into the narrow cleft-like space between the buccal shield and the post-oral lamella, and thus into the mouth.

### *Plumes.*

The plumes, of which there are usually fourteen, are more or less symmetrically disposed. The inner face of each (*i.e.*, that face which is directed towards the middle of the bunch of plumes) is convex as regards its length (figs. 25–27, plate 5), and is also convex as regards its breadth, except for a shallow and narrow groove which extends along the basal two-thirds and separates the two broad bands of pigmented epithelium. This groove, which marks the position of the nerve of the plume-axis, dies away towards the extremity, and the two black bands approach one another and fuse into one broad band. At its middle the axis is about twice or two and a half times as broad as it is thick.

The apex of the plume varies in shape according to the degree of extension of the whole plume. In a moderate state of contraction, such as that in which the majority of the plumes are found, the apex is rounded, smooth, black all over, and bears no pinnules (figs. 23 and 26). In consequence of the curvature of the axis the true shape of the apex is not readily made out, for the plume cannot be got to lie flat without applying so much pressure that the apex breaks up, and a side view is difficult to obtain on account of the breadth of the axis. A few specially good examples of plumes are shown in figs. 23–27.

The extremity is not differentiated to the same extent as is that of *C. dodecalophus*; it does not appear like two-thirds of a sphere set upon the end of the plume-axis. The cavity of the plume-axis does not enlarge at the extremity as it does in *C. dodecalophus*, and the cells of the extremity are not different from those pigmented cells of the central face of the plume-axis, whereas in *C. dodecalophus* the cells of the apical enlargement are much taller and more regularly set than those of the face of the plume-axis.

Plumes found fully extended have the terminations almost invariably damaged, but in fig. 24 is shown a plume in moderate extension, and in this one and in the

remnants of injured, fully-extended plumes the apex is seen to be pointed. A plume in the ordinary condition is about ·8 mm. or 1 mm. in length; a fully extended plume is 4 mm. long.

On the outer face of the plume-axis, between the two series of pinnules, is a ciliated groove, broad, deep and V-shaped in section at the base of the axis, narrow and about as deep as wide along the greater part of it (fig. 28). Towards the tip the groove dies away, and the outer face of the terminal portion of the axis is slightly convex.

The pinnules arise from the edges of the outer face of the plume-axis, and form a regular and close-set series from the base of the axis to near the tip (fig. 23). The pinnules arise obliquely along the edges of the axis, so that in a transverse section of a plume almost all of the sections of the pinnules are oblique. Further, the epithelium of the pinnule is continued along the grooved face of the plume-axis as an oblique ridge which stops only just before reaching the median plane of the axis. A transverse section of the plume-axis, therefore, always shows the ciliated epithelium of the aponeural groove in the form of an irregular sinuous line (fig. 28, *c.e.*).

The interior of the plume-axis is occupied by a cavity, directly continuous with the collar-cavity, and traversed by fine trabeculæ, irregularly placed, and with small nuclei adhering to their sides (fig. 28). There is an important tract of longitudinal muscle fibre on the aponeural side of the plume-axis, lying to the inner or coelomic side of the layer of skeletal matter that underlies the superficial epithelium. On the neural side of the axis the muscle fibres are less abundant. There seems to be no special mechanism for the extension of the plume-axis, and Harmer is probably correct when he surmises (**10**, p. 42) that elongation is effected by fluid pressure in the collar coelom.

The section drawn in fig. 28 does not show the neural groove, being cut too near the apex of the plume-axis, and the two masses of pigmented epithelium on the neural face of the axis are closer together than they would be in a section taken nearer the base of the plume. Lying immediately internal to the nerve tract, and appearing as a space in the sub-epidermal skeletal layer, being bounded on all sides by the skeletal substance, is the blood-vessel of the plume (*b.v.*).

The pinnules form a regular and close-set series from the base of the axis to near the tip (figs. 23 and 26). The longest are those arising about half-way along the axis. The pinnules at the basal end are sometimes very short, but this is probably in plumes which have not yet reached their full development. The number of pinnules along each side of the axis varies from seventeen to fifty in plumes which have apparently reached their full development. The most distal pinnules may project beyond the apex of the plume-axis (figs. 24 and 27) or not (figs. 23 and 26).

In some cases the most distal pinnules of three or four of the plumes of the individual are found to be adherent to the margin of the tube in which the animal was living. They are greatly attenuated, and their cells are full of highly refractive,

colourless, transparent granules. Similar granules are found adhering to the surface of the pinnules. Extended pinnules such as these have sand-grains not merely entangled among them, but actually adherent to them. The other plumes of such an individual are in moderate extension only, and one is led to conclude from these relations that, at the time when the colony was placed in the preservative solution, the pinnules of the extended plumes were in the act of secreting one of those increments to the margin of the tube which a longitudinal section of the tube shows so sharply marked off from one another (fig. 12, plate 4). The secreted material, being presumably of a tenacious character, prevented the retraction of the plumes in question, whereas the other plumes were free to contract, and did so more or less. The sand-grains also which came up with the dredge became embedded in the newly-secreted material before it had had time to solidify.

Each pinnule is roughly circular in section (fig. 29, plate 5), and has a very slightly expanded extremity (fig. 33). A single unilateral series of the yellow-brown cells with one or two black dots occurs along the pinnule. There are none at the actual extremity, but at a short distance from the end there occurs a group of five or six.

A transverse section of a pinnule shows tall epithelium on one side and low epithelium on the other. The pigment cells occur among the latter (fig. 30). The high epithelium is on that side of the pinnule which is in relation with the aponeural surface of the plume-axis. The low epithelium with occasional pigment cells is continuous with the pigmented neural face of the axis.

Within the pinnule are two tubular cavities bounded by the skeletal basement membrane, and separated the one from the other by a curved wall of the same substance. The tube which is next the high ciliated epithelium is continuous with the coelomic space of the plume-axis, and contains here and there solitary coelomic nuclei. The other tube is probably a blood-space, although its communication with the main blood-vessel of the plume-axis has not been established by the careful examination to which the sections were submitted.

The plumes, although disposed in nearly radial symmetry at the anterior end of the body, are clearly collected into two groups, right and left. The lophophoral arm that bears the seven plumes of each side is short and nearly semi-circular. It is broadly attached to the body on the posterior side of its ventral half or more (viz., that nearest the buccal shield). The other part stands free from the body and bends back slightly, so that the sixth and seventh plumes appear to be set at a more posterior level than the first and second (*i.e.* those nearest the shield). Two consecutive plume-axes touch one another at their bases, whereas the end members of the right and left series (viz., first and first and seventh and seventh) are separated from one another by a slight interval. The fourteen plume-axes are set around the margin of an elliptical area in a fairly orderly fashion, and the whole series of plumes can be laid out flat on a glass slip, radiating from a central point or from the two foci of an ellipse, without separating their bases.

The number of plumes is not constant. The commonest number is fourteen, but there may be as many as sixteen and as few as twelve plumes. A study of the buds shows that, as in *Cephalodiscus dodecalophus*, the full complement of plumes does not develop simultaneously, but successively, and the occasional presence of a very small plume among thirteen or fourteen large ones in a full-grown individual suggests that the number may be subject to increase even after the adult stage has been reached.

### *Stolon.*

The stolon is stout, short as compared with that of *C. dodecalophus*, roughly circular in section, and with a pigmented and transversely wrinkled surface. It does not taper, but is of fairly uniform diameter; its free or posterior end is hemispherical, and from the margin of this extremity the buds are developed. The angle at which the stolon stands out from the body differs in polypides found in tubes and those found free (see p. 26).

The longitudinal muscles in the stolon are disposed in the form of a thick-walled tube surrounding a mass of compacted coelomic corpuscles and trabeculae. There is no median septum in the greater part of the length of the stolon, it extends hardly beyond the base of that organ.

There is little variation in the shape of the stolon. In a full-grown individual with many buds it is always short, cylindrical and stout; but from the wrinkling of the superficial epithelium one may conclude that the organ has been fixed by the preservative fluid in a condition of extreme contraction. As is explained later in the remarks upon budding, a large bud may develop at that end of its stalk which is attached to the parent stolon a small bud of its own. On the separation of the bud from the parent form, its stalk becomes its stolon, and the bud already present at its end, and those developed later, have relations to this stolon similar to those which the buds of the parent form bore to the parent stolon. The interesting feature to be noted here is that the stalk of the large bud in question is not always found in a state of contraction; in most cases it is two or three times as long as the stolon of the parent, and is slender in proportion.

If one assumes that the parental stolon is in a fully contracted state, the explanation of the granular mass in the middle of it is not far to seek. The stolon is to be regarded as a hollow structure, with the coelomic cavity traversed by connective tissue strands with the characteristic prominent lateral nuclei, and by an excessive diminution in the length of the stolon these threads and nuclei become all crowded together and form a dense core, the coelomic cavity as a cavity disappears in the stolon itself, and only remains recognisable in the basal part. In a male individual with large testes a limb of one of them may extend into the basal part of this granular core of the stolon.

The question why the stolon of full-grown individuals is invariably contracted

while the stalks of buds are not, in other words, why the stolon is so much more acutely sensitive than the stalks of the buds to those irritant influences which cause contraction, remains yet to be answered.

### *Coelom.*

There are, as in *C. dodecalophus*, five divisions of the coelom; one in the buccal shield (proboscis cavity), opening among the bases of the plumes by two small pores (proboscis pores), and having a pericardial cavity lying within it; a pair of cavities in the anterior part of the body (collar cavities) continued into the post-oral lamella and into the plumes; and a pair of large trunk cavities.

The collar cavities are a little smaller than the proboscis cavity. In their middle portions, just dorsal to the pedicle of the buccal shield, they come close together, and are separated by a small, thin mesenteric fold; they extend into the short pedicle of the buccal shield, and are separated from the proboscis cavity by a thin wall of a similar nature. The two collar cavities come together also behind the mouth, where they are separated by a small mesenteric septum only. Each collar cavity opens on to the exterior by a narrow tubular passage, which is lined by ciliated epithelium, and curves round and opens dorso-anteriorly to the gill slit. Posterior to this "collar-pore" is a ridge of specialised epithelium, consisting of tall columnar cells, presumably of a sensory nature. The collar canal marks the posterior limit of the collar cavity.

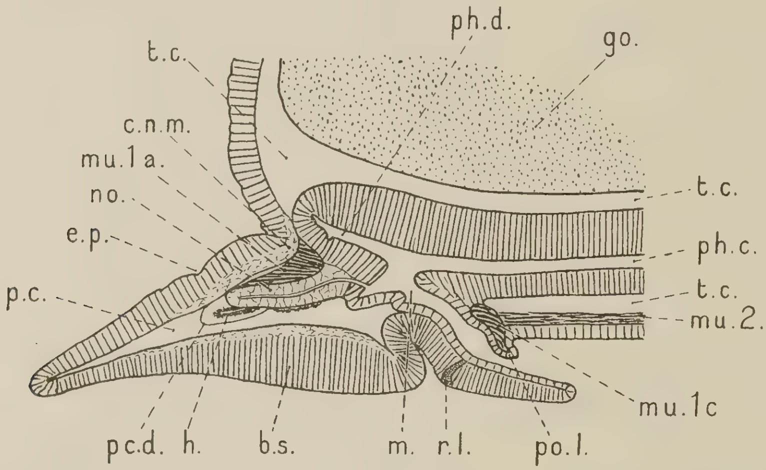
The separation of the two large trunk cavities (abdominal cavities) is probably in all cases incomplete owing to the imperfection of the mesenteric fold. In the anterior part of the trunk coelom there is a fold which extends from the pharynx to the gastric caecum, and from the sides of this fold there pass out short folds to the anterior portions of the two gonads. Behind the mouth, but anterior to the point at which the stolon leaves the body, is another fold, extending from the pharynx to the ventral body wall. A similar fold is found between the intestine and the dorsal body wall, but there appears to be none between the stomach and the intestine, which seem invariably to be in close contact. The trunk cavity is not definitely continued into the stolon, for this is largely choked up with coelomic corpuscles, but a continuation of the mesenteric fold can be recognised in the basal part of the stolon, extending from the one blood-vessel to the other.

### *General Internal Structure.*

In the present section of the paper a general account is given of the internal organs, based mainly upon the appearances which they present in sections of the body taken through structures of particular interest. Six such sections are drawn in text-figures 10–15. These figures are composite figures, each constructed from sections

of four or five polypides. An attempt has been made to place the pen-strokes and dots in such positions and at such distances apart as shall give the general appearance and depth of tint of the several tissues as seen under the low power of the microscope; the small rectangular and polygonal areas enclosed by the pen lines are not intended to represent cells, except in a most diagrammatic manner.

The general internal structure of *Cephalodiscus nigrescens* does not differ in any important respects from that of *C. dodecalophus* as made known to us by the writings of Harmer and Masterman. By its superior size *C. nigrescens* presents great advantages over *C. dodecalophus* as an object for investigation, but, while most of the details of the chordal, nervous, muscular and coelomic systems described in accounts of the latter species can be recognised in the former, only a certain proportion of the blood-vessels described by Masterman in *C. dodecalophus* can be identified




TEXT-FIGURE 10.—Median longitudinal section of the antero-ventral part of a polypide of *Cephalodiscus nigrescens*. *b.s.* = thickened ventral wall of the buccal shield; *c.n.m.* = central nerve mass; *e.p.* = ectodermal pit; *go.* = gonad; *h.* = heart; *m.* = mouth; *mu.*1*a*, *mu.*1*c*, *mu.*2 = muscle (see text); *no.* = notochord; *p.c.* = cavity of the buccal shield, proboscis cavity; *pcd.* = pericardium; *ph.d.* = pharyngeal diverticulum; *po.l.* = posterior part of the post-oral lamella; *r.l.* = red line of the shield; *t.c.* = trunk cavity.

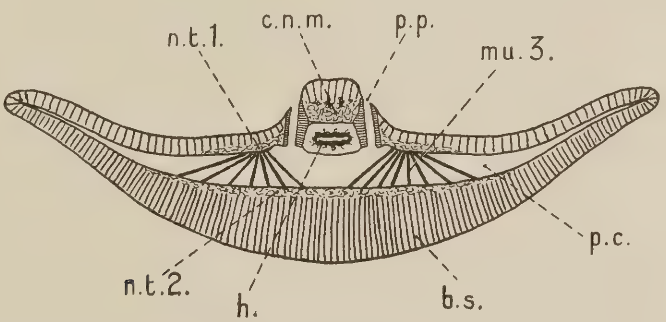
with any degree of confidence in *C. nigrescens*, and no light is thrown on the course taken by the blood in the vessels.

The notochord (subneural gland of Masterman) has a well-defined and continuous lumen, and does not open into the dorso-anterior diverticulum of the pharynx, as, according to Harmer (**10**, p. 54) it does in *C. dodecalophus*; its opening is situated more ventrally (text-fig. 10, *no.*). The anterior end of the notochord is in contact with the central nerve mass, as also are the pericardium and the pharyngeal diverticulum (*ph. d.*). The pericardial sac does not extend over the dorsal side of the tip of the notochord as it is described as doing in *C. dodecalophus*, but it projects back beneath the notochord to a greater extent than in the latter species. The heart is not fixed to the end of the notochord, but to the ventral side of its extremity.

Between the notochord, the central nerve mass, and the pharyngeal diverticulum

is a triangular space occupied by the median septum between the right and left collar cavities; and along each face of the septum there run muscle fibres in the direction indicated in text-fig. 10 at *mu.* 1*a*. (See also text-fig. 12, *mu.* 1*a.*) Between the collar septum and the central nerve mass is a narrow cleft, the dorsal blood sinus; this is marked *d. b. s.* in text-fig. 12, and is shown, but not marked, in text-fig. 10. There seems to be no direct connection between this space and the cavity of the heart. On the ventral side of the middle part of the notochord is an irregular tissue (text-fig. 10), but there is no cavity that can be identified as the ventral blood sinus of Masterman.

The heart (text-figs. 10, 11 and 12, *h*) is a sac, apparently closed, situated with its front part free in the pericardium and the hinder part attached to the lower surface of the notochord. Projecting from the surface of the heart are irregular, short threads, which appear to be broken coelomic trabeculae. They have small spherical nuclei placed upon their sides, as one finds in the coelomic trabeculae of the proboscis cavity and collar cavity, and they probably extended, when perfect, to the wall of the pericardial sac.




TEXT-FIGURE 11.—Section of a polypide of *Cephalodiscus nigrescens* taken transversely to the length of the body, and passing through the proboscis pores and the front part of the heart. The odd sections of plumes which are almost invariably included in such a preparation as this are not shown.

*b.s.* = thickened ventral wall of the buccal shield; *c.n.m.* = central nerve mass; *h.* = heart; *mu.*3 = radiating muscle fibres passing across the cavity of the buccal shield; *n.t.*1, *n.t.*2 = nerve tracts (see text); *p.c.* = cavity of the buccal shield, proboscis cavity; *p.p.* = external opening of the buccal shield, proboscis pore.

The buccal shield has frequently a strong transverse wrinkle such as is shown in text-fig. 10, in front of the red-line (*r. l.*) The posterior lobe of the shield is thinner than the central part, and consists of the ventral and dorsal or ad-oral walls almost in contact, the coelomic space being here reduced to a barely recognisable cleft.

The proboscis pores, or openings of the buccal shield, are a pair of narrow tubular passages lined with prismatic epithelium, and situated at the sides of the pericardium (text-fig. 11, *p. p.*) and at a level anterior to the tip of the notochord. The nerve tracts marked *c. n. m.* and *n. t.* 1 in text-fig. 11 are continuous both in front and behind the proboscis pores. The ectodermal pit (text-fig. 10, *e. p.*) is constant in its occurrence, but it has the form of a wrinkle in the antero-dorsal wall of the shield rather than of a definite sensory organ, a relation which bears

out the conclusion arrived at by Harmer in the case of *C. dodecalophus* that the importance attributed to the ectodermal pit by Masterman is unmerited.

From two small areas on the dorsal wall of the buccal shield there radiate muscle fibres which are inserted into the coelomic face of the thickened central part of the ventral wall of the shield (text-fig. 11, *mu.* 3 ; see also text-fig. 12).

The muscles that run between the basement membrane underlying the central nerve mass and the notochord, on either side of the median septum between the right and left collar cavities (text-figs. 10 and 12, *mu.* 1*a*), send some of their fibres backward on the right and left sides of the mouth, just ventral to the dorsal diverticulum. Posterior to the level of the oral aperture these converge, and become applied in the form of two sheets to the sides of the septum which divides the right and left collar cavities in the region of the posterior edge of the post-oral lamella (text-fig. 10, *mu.* 1*c.*), and to adjacent parts of the dorsal and ventral walls of the collar cavity. The two tracts of muscle shown in text-fig. 10 at *mu.* 1*a.* and *mu.* 1*c.* are thus in reality terminal parts of the same muscle. The middle part runs by the side of the mouth, and is seen in text-fig. 13 at *mu.* 1*b.* This muscle, called by Harmer the "oral muscle," stops immediately in front of the anterior end of the muscle tract of the ventral body wall (text-fig. 10, *mu.* 2), which continues back into the stolon as part of the longitudinal muscle of that organ, but, as Harmer has pointed out in the case of the species examined by him, the muscle fibres do not pass through the septum that separates the collar cavity from the trunk cavity.

At the side of the base of the notochord a few of the fibres pass ventrally and terminate in the septum between the collar cavity and the proboscis cavity on the dorsal side of that small area from the ventral side of which the radiating muscles of the proboscis cavity arise. Beneath the central nerve mass a few of the fibres of *mu.* 1*a* are continued forward into the dorsal wall of the front part of the shield, passing externally to the proboscis pores; others pass out laterally as a thin sheet lying immediately below the nerve mass, and these are continued into the plume-axes.

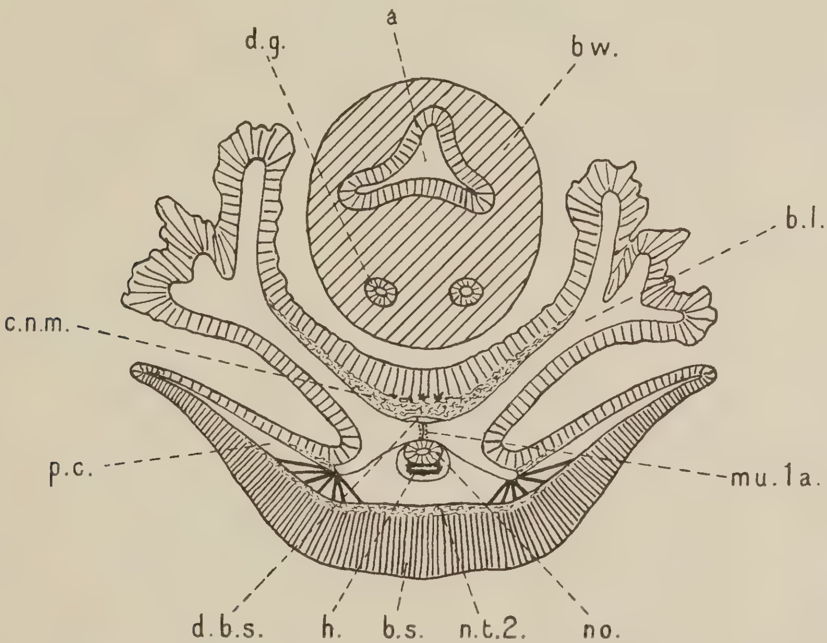
The section drawn in text-fig. 12 is taken only slightly behind that shown in text-fig. 11. It shows the front parts of the right and left collar cavities, separated from one another by a muscle-flanked septum (*mu.* 1*a*), and separated by more extensive septa from the cavity of the shield. The base of each half of the lophophore divides roughly into three parts before breaking up into the seven plumes ; the base is necessarily cut obliquely, and the outline is consequently irregular. The cavity of the collar is continuous with that of the lophophore and its plumes ; the indicating line marked *b.l.*, points to the cavity of the lophophoral base.

The central nerve mass (*c.n.m.*) shows a few large ganglion cells in its dorsal layer immediately beneath the superficial epithelium, and the nerve tracts that lead out sideways into the base of the lophophore are continued into the plumes as the

branchial nerves. The shield shows nerve tracts in both its ventral and dorsal walls; that of the former is a continuous sheet, that of the latter is paired.

The section passes tangentially through the anterior part of the "visceral mass" of the body, and includes sections of the gonad ducts and of the terminal portion of the intestine. Had the section been taken a little farther back the spacious trunk cavity would have come into view.

Text-fig. 13 shows a section taken through the mouth and the collar canals. Such a section passes behind the stalk of the buccal shield, and shows a very thick dorsal wall to the pharynx, with lateral parts, the pleurochords (*pl.*), of a paler tint and with a strong groove on their inner surface. The lateral flaps of the post-oral lamella (*po. l.*) are shown as bent over towards the mouth, a relation which they frequently




TEXT-FIGURE 12.—Section of a polypide of *Cephalodiscus nigrescens* taken transversely to the length of the body, and a little farther back than that shown in text-fig. 11. It passes through the front part of the notochord and the hinder part of the heart.

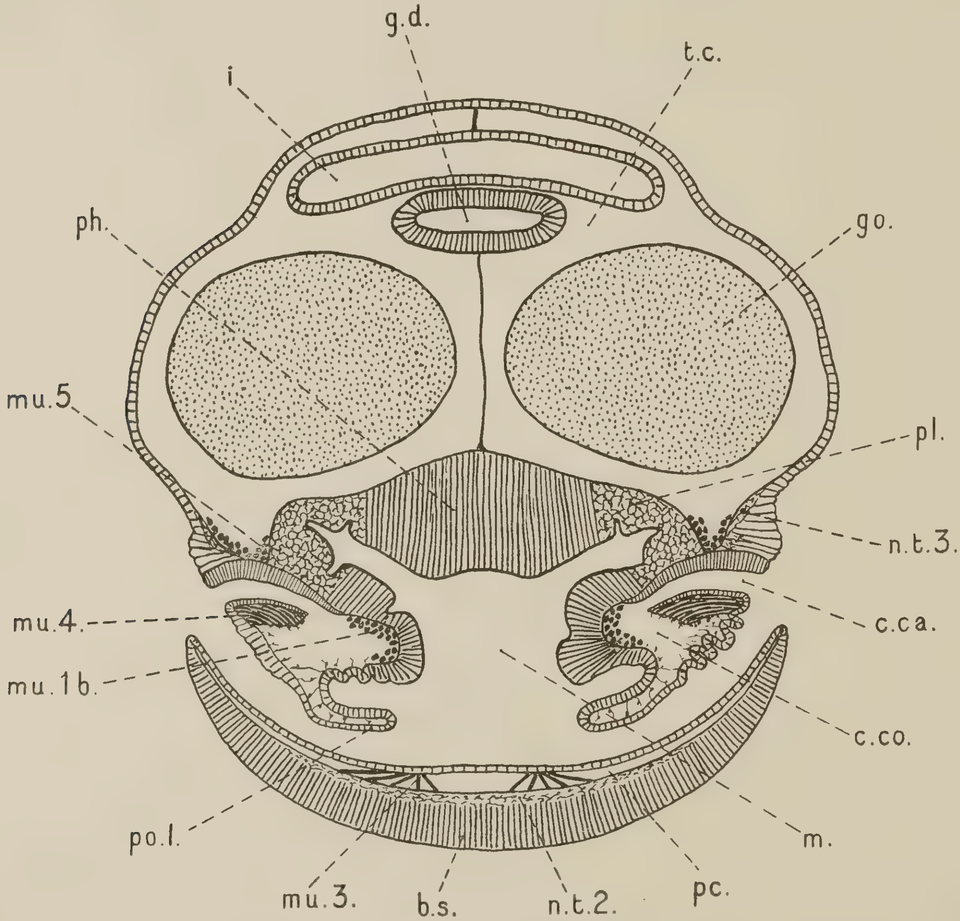
*a.* = anus; *b.l.* = base of the lophophoral system; *b.s.* = thickened ventral wall of the buccal shield; *b.w.* = anterior body-wall, cut tangentially; *c.n.m.* = central nerve mass; *d.b.s.* = dorsal blood-sinus; *d.g.* = duct of the gonad; *h.* = heart, lying within the pericardium; *mu.1a.* = muscle fibres passing along the side of the septum between the right and left collar cavities; *no.* = notochord, in transverse section; *n.t.2* = nerve tract; *p.c.* = cavity of the buccal shield; proboscis cavity.

possess, but in some slides the flaps are outwardly directed, so that their free edges are near, or succeed in covering, the openings of the collar canals.

The collar cavity is here fairly spacious (*c. co.*) and is seen to extend into the post-oral lamella, the two walls of which are connected here and there by fine coelomic trabeculae with lateral, spherical nuclei. The epithelium of the dorsal wall of the collar canal is taller than that of the ventral wall, and the internal opening of the canal is smaller than the external. The fibres of the oral muscle,

passing along the mesial wall of the collar coelom, are seen in transverse section (*mu.* 1*b.*), and the fibres of the collar canal muscle (*mu.* 4), the 'problematical body' of Harmer, are cut obliquely, but more longitudinally than transversely. A special section of the paper is devoted to a consideration of this body (p. 41).

The section drawn in text-fig. 14 is taken only slightly behind that represented in text-fig. 13. It cuts the hind edge of the mouth almost tangentially (*se. t.*); but if the polypide dies with its mouth widely open, a transverse section taken through the gill-slits will pass also through the mouth opening. The small septum



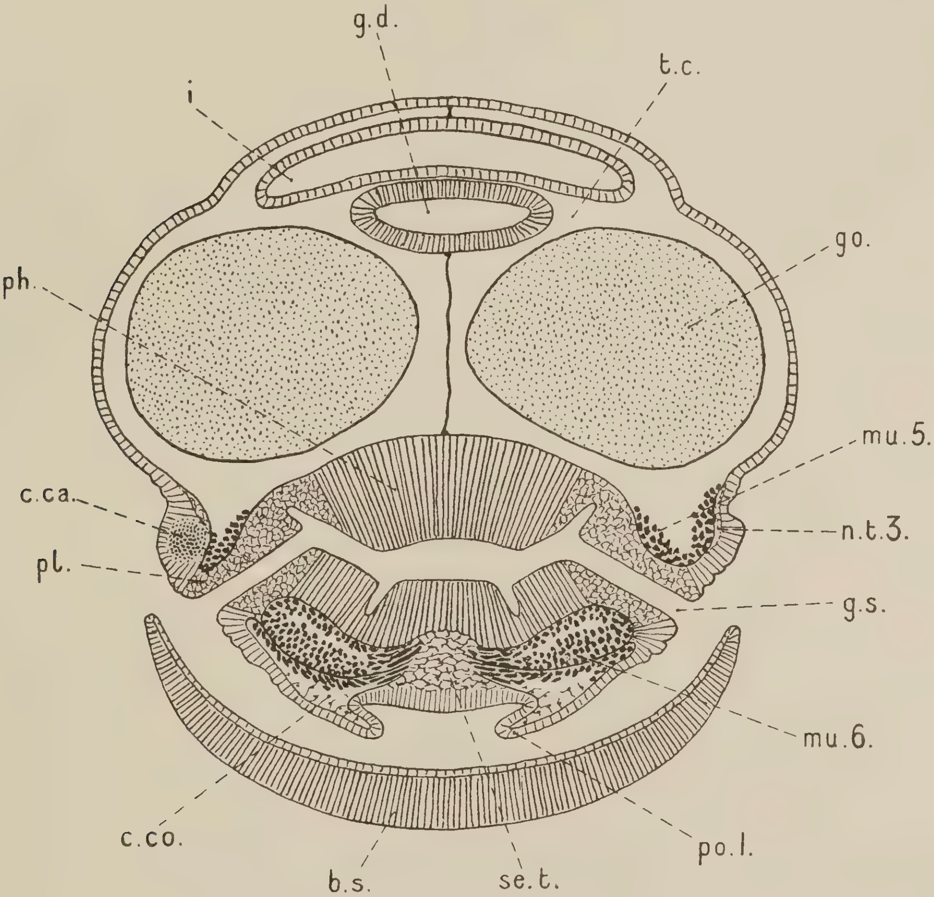

TEXT-FIGURE 13.—Section of a polypide of *Cephalodiscus nigrescens* taken transversely to the length of the body, and passing through the collar canals and the mouth aperture.

*b.s.* = thickened ventral wall of the buccal shield; *c.ca.* = collar canal; *c.co.* = collar coelom; *g.d.* = gastric diverticulum; *go.* = gonad; *i.* = intestine; *m.* = mouth; *p.c.* = cavity of the buccal shield, proboscis cavity; *ph.* = dorsal wall of pharynx; *pl.* = pleurochord; *po.l.* = lateral flap of the postoral lamella; *mu.*1*b*, *mu.*3, *mu.*4, *mu.*5 = muscle (see text). The tract marked *mu.*4 is the problematical body of Harmer. *n.t.*2, *n.t.*3 = nerve tracts; *t.c.* = trunk coelom.

between the right and left collar cavities is situated immediately posterior to the part marked *se. t.* By the side of *se. t.* are seen some of the median ventral muscle fibres (text-fig. 10, *mu.* 2) passing forward obliquely into the anterior horns of the trunk coelom, and some of the fibres of the oral muscle in the collar cavity are

seen passing backward obliquely to complete their course along the septum between the right and left collar cavities (text-fig. 10, *mu.* 1*c.*).

The gill-slit slopes from the pharyngeal cavity ventro-laterally and in the transverse plane. The collar canal slopes from the collar cavity dorso-laterally, and slightly backward. The external opening of the collar canal is more dorsal than that of the gill-slit, and a little more anterior. The gill-slit is such a short distance behind the collar canal that only occasionally, as is shown on the right side of the text-fig. 14, is the canal wall missed entirely; more usually



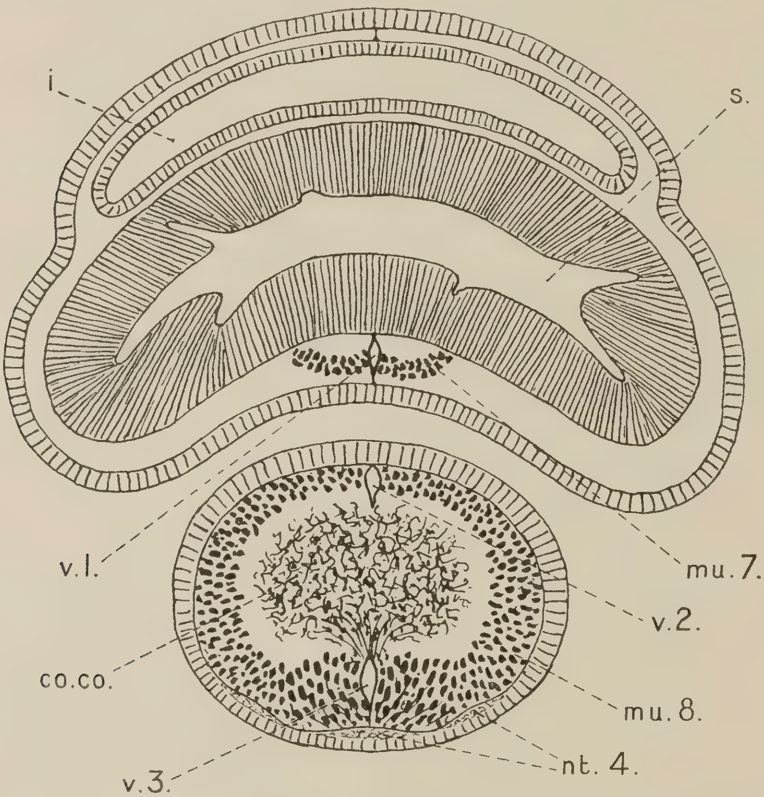

TEXT-FIGURE 14.—Section of a polypide of *Cephalodiscus nigrescens* taken transversely to the length of the body, and a little farther back than that shown in text-fig. 13. It passes through the gill-slits, and immediately behind the mouth. *b.s.* = thickened ventral wall of the buccal shield; *c.ca.* = part of the posterior wall of the collar canal cut tangentially; *c.co.* = collar coelom; *g.d.* = gastric diverticulum; *go.* = gonad; *g.s.* = gill-slit; *i.* = intestine; *ph.* = dorsal wall of pharynx; *pl.* = pleurochord; *po.l.* = postero-lateral flap of the post-oral lamella bent over towards the mouth; *mu.*5, *mu.*6 = muscle (see next); *n.t.*3 = longitudinal nerve tract; *se.t.* = subepidermal tissue behind the mouth, cut tangentially; *t.c.* = trunk coelom.

the tangential section of the external part of the canal wall is included (text-fig. 14, *c. ca.*).

As in the previous figure, the trunk cavity is conspicuous, and is occupied, at this particular level of section, by the two gonads, the intestine and the anterior

extremity of the gastric diverticulum. It is divided by a median septum, which is readily recognisable between the pharynx and gastric caecum, and between the intestine and the dorsal body wall, but not between the gastric caecum and the intestine, these being found to be invariably in close contact. In sections taken farther forward than that represented in text-fig. 13, but not so far forward as that shown in text-fig. 12, a lateral mesenteric fold is to be seen extending outward to the gonad duct from the median septum that extends from the dorsal wall of the pharynx to the intestine.

A section taken transversely through the hinder part of the body at about




Text-Figure 15.—Section of a polypide of *Cephalodiscus nigrescens* taken transversely to the length of the body, and passing through the basal end of the stolon.

*co.co.* = coelomic contents, consisting of fine trabeculae and their nuclei, and entangled coelomic corpuscles; *i.* = intestine; *mu.*7, *mu.*8 = muscle (see text); *n.t.*4 = nerve tract; *s.* = stomach; *v*1, *v*2, *v*3 = blood-vessels (see text).

the level of the basal part of the backwardly directed stolon (text-fig. 15) shows the trunk cavity occupied by the flattened stomach and intestine. The stolon itself is nearly circular in section, and its ventral epithelium is composed of smaller and less deeply pigmented cells than the dorsal and lateral parts. A nerve tract (*n. t.* 4), partially divided into three, is seen adjacent to the small epithelium cells of the ventral surface. The coelomic cavity of the stolon is largely obliterated by a mass of compacted trabeculae and their nuclei, with entangled

coelomic corpuscles (*co. co.*). At the extreme basal end of the stolon a median septum is seen extending from the blood-vessel *v.* 2 to that marked *v.* 3. It is continuous with the body septum that stretches between the pharynx and the ventral body wall and divides the trunk cavity into a right and a left compartment, but it does not extend far down the stolon, and is already incomplete at the level of section represented in text-fig. 15.

Lying in the mesenteric fold below the stomach is a blood-vessel (*v.* 1) which passes forward, and on reaching the base of the stolon, passes downward, then backward along the dorsal wall of the stolon, and comes again into view in the section now under consideration at *v.* 2. The blood-vessel marked *v* 3 is continued forward into the body, running between the pharynx and the ventral body wall.

Passing longitudinally below the stomach, at *mu.* 7 in text-fig. 15, are some muscle fibres which can be traced forward as far as the base of the stolon. Here they curve down and then run back along the dorsal side of the stolon, by the side of the dorsal vessel of that organ (*v.* 2). The muscle fibres in the lateral and ventral parts of the stolon (*mu.* 8) are continued forward into the trunk as an extensive tract lying ventrally and laterally to the pharynx. The ventral part passes straight forward and stops a little distance behind the mouth (text-fig. 10, *mu.* 2), against the septum between the collar cavity and the trunk cavity. The lateral part, which is more bulky, forks on reaching the gill-slit into one part which runs dorsally to the slit and collar canal (text-figs. 13 and 14, *mu.* 5) and gradually thins out as its fibres are inserted into the body wall, and a second part which runs ventrally to the gill-slit and collar canal and ends at the front of the right and left anterior horns of the trunk cavity (text-fig. 14, *mu.* 6).

Lying immediately internal to the superficial epithelium of the stolon is a thin layer of muscle fibres, circularly disposed. In transverse sections of the stolon this layer might easily be taken for a layer of skeletal tissue; but in tangential sections of the layer the outlines of the individual fibres can readily be seen. The fibres are much finer than those of the bulky longitudinal muscles of the stolon, and are arranged in a very even and continuous sheet.

### *Collar-canal Muscle (Problematical Tissue).*

The transverse section of the collar canal of *C. nigrescens* has the form of an elongated ellipse set obliquely. The epithelium of the postero-dorsal side is composed of tall, closely-set prismatic cells bearing long cilia, the epithelium of the antero-ventral wall is thin, and is in relation with a short, stout tract of muscle fibres, which pass obliquely from this antero-ventral wall of the collar canal and the part of the body-wall which lies to the antero-ventral side of the collar pore. The most ventral of these fibres are attached to the dorsal (aboral) surface of the lateral flap of the post-oral lamella, the rest have no obvious attachment. This muscle

(text-fig. 13, p. 38, *mu.* 4) is the "problematical tissue" of Harmer (**10**, pp. 42–46). There is nothing in the present material to suggest that the structures in question are "lamellae," and not fibres. The slope of the collar canal and the obliquity of the muscle fibres to the antero-ventral wall of it are such that one's chances of obtaining the fibres cut at right-angles to their length are very remote. The ordinary sections that one takes for the study of the structure of *Cephalodiscus* are those cut transversely to the long axis of the body, those taken parallel to the sagittal plane, and those taken parallel to the ventral body-wall, *i.e.* parallel to the face of the shield. All of these will cut the muscle fibres obliquely; the chance of getting some of the fibres cut longitudinally is greatest in the third kind of section, but none of the three sections will show more than a few of the marginal fibres cut transversely. The fibres are, further, not disposed strictly parallel with one another, but they interlace slightly, so that in no case could all the fibres of one section present the same aspect.

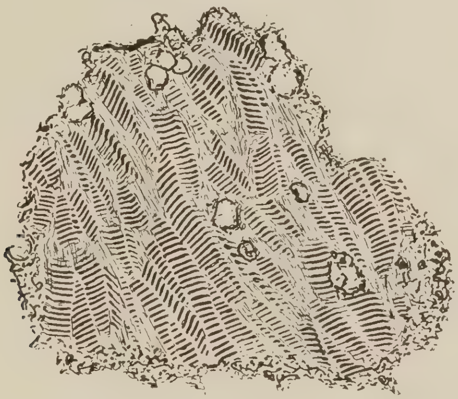
As surmised by Harmer, who, in spite of what he considers to be its exceptional shape, is disposed to regard the problematical tissue as contractile, the effect of the contraction of the muscles is clearly to dilate the canal by drawing away the thin antero-ventral wall from the stouter postero-dorsal wall. When the collar canal is nearly closed, the transverse section of its cavity is crescentic; when open, it is elliptical, possibly nearly circular.

The bodies in question are clearly those referred to as "solenocytes" by Schepotieff, and shown by him in his fig. 8 (**29**), and it is a curious coincidence that Harmer at first suspected that they might be solenocytes, and even submitted his preparations to Mr. E. S. Goodrich, in order to obtain the latter's opinion on the matter (**10**, p. 45). They are obviously not solenocytes, however. What gives them a faint resemblance to such excretory structures is the swelling which appears at the coelomic extremity of each obliquely-cut fibre. This swelling, there seems to be no reason to doubt, is due to the snapping of delicate fibres which in life must have passed across the collar cavity to the opposite wall, these fibres being possibly of a muscular nature themselves, like those that radiate across the proboscis cavity, but they were certainly not so thick; they must have resembled rather the ordinary coelomic trabeculae. The resemblance to the latter is further borne out by the presence of nuclei, exactly like those which are set upon the coelomic trabeculae, occurring in numbers on the coelomic surface of the muscle. What puzzles one at first is the relation of the muscle fibres to other parts; they have an origin, as pointed out above, but many, one might say most of them, have no insertion, the fibres curving round, and ending apparently against the coelomic cavity only.

The relations of the collar are probably such that, during the death struggles, when the animal is plunged into the killing fluid, these muscle fibres in all cases contract so violently as to break the trabecular connection extending from their coelomic extremities to the opposite wall, i.e. the ventral face of the lateral flap of

the post-oral lamella, the snapped threads drawing themselves and their nuclei up to the coelomic surface of the muscular fibres. It is a significant circumstance that while a greater or smaller number of perfect coelomic trabeculae are found in most parts of the collar cavity and the cavities of such out-growths from it as the plumes and post-oral lamella, only broken fibres are found projecting from that part of the post-oral lamella which lies immediately ventral and anterior to the collar canal muscle (text-fig. 13).

The present species possesses the advantage of superior size over those species examined by Harmer, and is consequently well adapted for the determination of the nature of the "problematical body." The muscle-fibres composing it can even be recognized as of the "cross-striped" variety (see text-fig. 16). It is worthy of remark that the collar canal muscle is the only cross-striped muscle in the body of *Cephalodiscus*. While cross-striped muscle fibre is widely spread throughout the Vertebrates and occurs in considerable bulk, in the Invertebrates it occurs only in



TEXT-FIGURE 16. Section of the collar canal muscle of *C. nigrescens* cut parallel to the ventral surface of the polypide, *i.e.*, parallel to the face of the buccal shield; as seen with Zeiss apochr. imm. obj. 2mm., compens. oc. 6; × 820.

isolated genera or families, and only in certain limited tracts of the body. A higher muscular efficiency and a more rapid contraction appear to be associated with this histologically differentiated muscular tissue, and one is led to the conclusion that the collar canal of *Cephalodiscus* is an organ of considerable importance.

### *Alimentary Canal.*

The alimentary canal differs from that of *C. dodecalophus*, mainly in that the stomach is not globular. The canal is in most cases empty, or nearly so. The first part of the tube (pharynx) has a thick wall, and is lined with ciliated epithelium. Projecting forward from its anterior wall is the notochord, a long, narrow, blind tube, with continuous lumen opening into the pharyngeal cavity, and with walls composed of pale-staining, vacuolated cells. The two gill-slits, right and left, are small oval apertures, symmetrically disposed and situated not far

behind the level of the mouth. Along each side of the pharynx a part of the wall is composed of pale-staining vacuolated cells—the pleurochord. The pleurochord has a groove which runs lengthwise along the lateral wall of the pharynx and opens into the gill-slit anteriorly. The pleurochordal cells surround the gill-slit.

The pharynx narrows very abruptly behind, and leads into the next portion (stomach) by a very small aperture. The stomach is in no case dilated; it is continued forwards as a caecum, of oval section and with thick walls, which lies between the intestine and the two gonads (see text-fig. 14, p. 39); and it leads at its posterior end into the intestine, which passes first ventrally, then posteriorly, then dorsally, and finally forwards, and opens by an anus at the front end of the body. In the specimens preserved in formalin the intestinal wall is pale green.

Much discussion has centred around the structures mentioned above as the notochord and pleurochords. The pleurochords were so termed by Masterman (**22**, p. 353, footnote), who, since the year 1896 (**20**, p. 64) is disinclined to recognise any homology existing between the median pharyngeal diverticulum above referred to as the notochord, and the notochord of the Vertebrata. He at first denied that any homology exists between the median diverticulum of *Cephalodiscus* and the Eicheldarm of *Balanoglossus*, but he has since ceded the point (**28**, p. 723) and admits an homology between the median diverticulum of *Cephalodiscus* and the vermiform process of the Eicheldarm. He homologises the former structure with the subneural gland of Tunicates (**22**, **23**, **27**, **28**), and now regards the Eicheldarm of *Balanoglossus* as a subneural gland also (**28**, pp. 723 and 724).

Willey has shown that the complete stomochord or anterior diverticulum with vacuolated walls occurring in the Enteropneusta exhibits strongly marked regional differentiation (**34**, p. 235, fig. 3), and he homologises Masterman's pleurochords of *Cephalodiscus* and *Actinotrocha* with the lateral pouches of the stomochord, and the median ventral diverticulum, arising from the anterior end of the intestine and underlying the oesophagus, described in *Actinotrocha* by Roule (Comptes Rendus, cxxvii., 1898, pp. 633–636, and Ann. Sci. Nat. Zool., xi., 1900; see also Ikeda, Journ. Coll. Sci. Imp. Univ. Tokyo, xiii., 1901, pp. 555–556), with the ventral caecum of the stomochord (**34**, p. 237). He agrees with Harmer (**7**, p. 342) that the notochord of *Cephalodiscus* (subneural gland of Masterman) is the equivalent of the vermiform process of the stomochord of the Enteropneusta, but in this connection it is to be noted that Harmer has recently stated (**10**, p. 65) that he regards the notochord of *Cephalodiscus* as equivalent not with the vermiform process alone, but with the entire Eicheldarm.

Willey shows further that the hinder region of the gut of the Enteropneusta may develope in its ventral wall a skeletal vacuolated structure, the pygochord (**34**, p. 234). The pygochord Masterman (Quart. Journ. Micr. Sci., xliii, 1900,

p. 412, footnote) compares with the chordoid structure which he found to exist (**22**, p. 305) in the mid-ventral wall of the stomach of *Actinotrocha.*

From all this it would appear to an unprejudiced mind that the gut-wall may develope tracts of vacuolated skeletal cells in any part of its extent, and that, except in the case of the notochord of the Cephalochorda and Vertebrata, which occupies a definite position between the central nervous system and the enteric tube, any close comparison of these various tracts in the different forms of the Chordata is almost impossible.

The suggestion of Masterman (**22**, p. 356, and **25**, p. 915) that the pleurochord of *Cephalodiscus* is a skeletal structure developed in the wall of the pharynx for the purpose of keeping open the gill-cleft, and Willey's remark (**34**, p. 238) that a long pleurochord may mark the position of a row of obliterated gill-slits, are worthy of careful consideration. In the Cephalochorda, Cyclostomata, Fishes, and Amphibia, the positions between the gill-slits are supported by skeletal tissue (mesoblastic, it is true, whereas the pleurochord is hypoblastic), and it is not unreasonable to suppose that the long pleurochord of *Cephalodiscus,* with the gill-slit at its anterior end, may represent the skeleton of a series of slits, only one of which now appears in ontogeny; and further, that in *Actinotrocha* (Masterman, **22**) and *Rhabdopleura* (Schepotieff, Bergens Mus. Aarbog, 1904, p. 14, Kiemenrinne) the skeletal matter of the slit develops ("liver d verticula" of earlier writers (Masterman, **22**, p. 304)), although the slits themselves never make their appearance. Willey claims that the lateral pouches of the stomochord of the Enteropneusta are the "persistent vestiges of primitive gill-clefts belonging to that portion of the body which, in the Enteropneusta, is now specialised as the collar region" (**34**, p. 238).

## *Gonads.*

The individuals of the species under consideration possess either two ovaries or two testes, or an ovary and a testis. In a series of thirty-six individuals examined, fifteen had two ovaries, seven two testes, and fourteen an ovary and a testis. The three kinds of individuals are not restricted in their distribution. The same branch of the colony may have male, female, and hermaphrodite individuals, and no distinction can be drawn as regards sex between the individuals found in the basal, middle, and more terminal portions of the same branch of the colony.

If the gonads are large they bulge somewhat upon the sides of the body, and by stretching the pigmented body-wall that covers them, cause it to be paler than the other parts of the surface (see figs. 7 and 8, plate 3).

The ovary is narrow at its anterior extremity, where it opens upon the exterior by a short duct with a small, frequently ill-defined cavity, and with walls of a red colour, which resembles that of the red line in the buccal shield in tint and in being

unaltered by alcohol, formalin, and glycerine. The ovary may be described as a sac, to one side of the interior of which are attached the ova (figs. 38–40, plate 5). The side in question is that farthest from the median plane of the body. The smallest ovicels are those at the oviducal or anterior end of the ovary, and the size of the cells gradually increases as one passes towards the broad end. The larger ovicels are more or less comma-shaped (fig. 40), which suggests that the proliferation of the germinal cells takes place near the oviduct and on the side of the ovary farthest from the median plane of the body, and that the production of the new cells causes a backward distortion of the cells proliferated at an earlier period, so that these latter have each a kind of tail directed towards the anterior end of the outer wall of the sac. The hindermost member of the series is in some ovaries vastly larger than its neighbours, and has become rounded off (fig. 38). It is heavily charged with yolk.

The large ripe ovum, free in the ovarian sac, presumably escapes by passing forwards between the mesial wall of the sac on the one side and the layer of ovicels on the other, and, by causing a great distension of the red oviduct, passes out to the exterior. There is in the present species no evidence to support the suggestion of Masterman in the case of *C. dodecalophus* (**24**, p. 512) that the oviduct serves merely for the admission of the spermatozoa, and that the ova do not escape by way of this duct, but are set free only by the death and disintegration of the body of the parent. Indeed, the occurrence of an ovum in some specimens lying entangled among the bases of the plumes immediately over the oviducts points to the normal extrusion of ova through these ducts.

At the posterior end of some ovaries occurs a kind of collapsed and irregular tube (fig. 39), which looks as though it were an oviduct; and the supposition is strengthened by the ripest ova being found towards this extremity of the ovary. But examination of sections shows that the tube in question ends blindly. Moreover, the ducts of the testicular sacs of the male occur in positions corresponding exactly with those of the red ends of the ovaries of the female, and the lumen of the male duct is invariably clear, and bounded by well-defined epithelium. The tube at the posterior end of the ovary is in all probability the hinder portion of the ovarian sac which has collapsed after the discharge of a ripe ovum, and has not yet been filled out by its successor. A similar twisted tube is present in *C. dodecalophus.*

Liberated ova are found singly among the buds in the blind ends of inhabited tubes of the colony. They are yellowish white in colour, ·7 mm. in length and ·6 mm. across. No segmenting ova have been met with.*

The testis, when small, has the form of a pear-shaped sac, and bears a general external resemblance to an ovary; but when fully formed it is much larger than an ovary, and is cylindrical in shape, frequently distorted, however, by pressure of parts of

* Since the above was written, sections have been cut of some eggs of *C. nigrescens* which prove to be in a state of segmentation. The only stage met with up to the date of this footnote is one in which a single layer of tall, narrow cells surrounds an undivided mass of yolk. July 22, 1906.

the alimentary system (fig. 37, plate 5). A large testis extends as far as the extreme posterior end of the visceral mass, and may occasionally send off a lateral branch which is lodged in the stolon. The duct at the anterior, pointed end of the testis differs from the corresponding duct of the ovary in having no red pigment, or at most a few specks of red.

A transverse section of the testis shows a moderately thick wall of uniform character throughout (except in the foremost portion or duct), composed of four or five layers of cells in various stages of spermatogenesis. The central cavity is occupied by large masses of spermatozoa.

The openings of the ducts of both ovaries and testes lie at the bottom of shallow depressions, the epithelium of which is composed of taller and more closely set cells than those investing the greater part of the body.

### *Buds and Budding.*

A bud in its earliest stages of development appears as a small clavate mass (fig. 60, plate 7), the free end of which gradually flattens out (fig. 61), and becomes differentiated from the "body." The flattened terminal portion is of semicircular outline, and develops into the anterior part of the buccal shield. The red line of the buccal shield appears at about this stage, before the posterior edge of the shield is clearly outlined. The shield becomes broader and more sharply defined from the "body" (fig. 62), and grows at a much faster rate than the latter (figs. 63–65).

Fig. 65 gives a side view of a bud of the same age as that represented in fig. 64, and serves to show the great mobility of the shield even at this early period of development. The posterior flap of the shield can be brought sharply forward, *i.e.* ventrally, and the "body" appears as an elongated pyriform structure projecting from the middle of the dorsal surface of the shield, and is continued back into the tapering stalk.

Shortly after this stage is reached the plumes begin to develop, as small hemispherical projections situated dorsally to the middle of the shield, and arranged in a curved line that runs immediately anterior to the "body" (fig. 66). The plume-axes elongate and flatten into thick ovate discs, and the pinnules grow out from the edges.

After this, the shield increases at a relatively slower rate, the body enlarges rapidly (fig. 67), and, in the later stages, the visceral mass begins to bulge posteriorly (fig. 68), so that the stalk is no longer terminal, but on the ventral side of the body. The plumes by this time have increased to the number of twelve or fourteen, and the line of their bases has gradually changed from a semicircle to almost a circle.

As in *C. dodecalophus*, the shield of a young bud (with two pairs of plume-

axes only) is considerably longer* than wide (text-fig. 9, A, p. 27), and when four pairs of plumes are recognisable the same relation holds (text-fig. 9, B). In the adult, however, the antero-posterior diameter is only slightly greater than the maximum width (text-fig. 9, C). In *C. dodecalophus* the width is a little greater than the antero-posterior diameter (text-fig. 17, F, p. 54). In buds of *C. nigrescens* the width of the hinder lobe is less than that of the front lobe, but in adults it may be wider or narrower than the front lobe, or equal to it in width. The distance from the centre of the red line to the anterior edge of the shield is in young buds about twice the distance from the red line to the posterior edge. In adults the proportion is $2\frac{1}{2}$ times or $2\frac{3}{4}$.

The stalks of buds of medium and large size are found in various degrees of contraction and extension, and even the same stalk may in one place be thin and smooth, and in another stout and transversely wrinkled. The stalks are so extensible in half-grown buds that these buds may be found entangled among the plumes of the parent individual, or may even project beyond. The stalks of such buds are of course greatly attenuated.

Before severing its connection with the parent stolon, a large bud usually develops, at the side of the extremity of its stalk, a bud of its own, so that if the parting occurs at the extremity of the stalk (which is not always the case), the stalk has now to be regarded as the stolon of the liberated bud, with the first of its series of buds already present.

The bases of the bud-stalks of an individual with several buds are disposed more or less in a circle around the hemispherical termination of the stolon, or slightly to one side of it. The order of sequence of the buds is not easy to trace, but it is not unusual to find small buds alternating with large buds around the circle. Figs. 69–75, plate 7, show the appearance of the end of the parent stolon after the stalks of the larger buds have been unravelled, and cut close to their origins.

A feature of especial interest, as pointing to the possibility of the recognition in the stolon system of *Cephalodiscus* of such a system of branching as occurs in *Rhabdopleura*, is the occurrence—rare, it is true—among the buds at the end of the parent stolon of a sausage-shaped piece which at its free end has a rosette of buds of its own (figs. 69, 71, 73). In buds half-grown and older the stalk, as has already been noted, may be slender and attenuated in parts, while short and transversely wrinkled in others. These latter parts are sausage-shaped, and pinched at one or both of their extremities, and the most plausible explanation of the above double rosette of buds seems to be that a full-grown bud may sever its stalk at any point, and that not only does the free extremity of that part of the stalk which remains attached to the liberated bud possess the capacity of developing buds of the next generation, but the free end of the other portion

* For comparisons of this kind the shield is removed and mounted for examination under the microscope.

of the stalk also. If this be so, the buds marked F, G, H, J, K, in fig. 73 are buds of a later generation than those marked A, B, C, D, E.

In one case examined (fig. 71), two such secondary stolons were found. In this case there are no buds on the main or parental stolon, one moderately large bud and a larger bud with long thin stalk on one secondary stolon, and two small buds on the other. In another case (fig. 69) there is a long-stalked bud and a secondary stolon arising from the parental stolon, three young buds and a tertiary stolon at the end of the secondary stolon, and a small bud, a large bud with plumes, and a larger, long-stalked bud arising from the extremity of the tertiary stolon.

## DESCRIPTION OF *CEPHALODISCUS HODGSONI* (SEE P. 3).

### *Material.*

The material of *Cephalodiscus hodgsoni* consists of eight specimens, of which five (for convenience of subsequent reference here called A, B, C, D, E) were dredged on the same day (January 29th, 1902) in 100 fathoms off the east end of the Barrier, 78° 16′ 14″ S., 197° 41′ 47″ E., where the bottom is described as consisting of "mud, stones, and rocks." A sixth specimen (F) was obtained two days earlier and at a greater depth (January 27th, 1902, 300 fathoms, off Barrier, bottom mud), while the other two were obtained in the following year when the boat was in winter quarters, specimen G on May 18th, 1903, No. 10 hole, 130 fathoms, and specimen H on June 3rd, 1903, No. 10 hole, 130 fathoms.

The largest pieces are B (fig. 1, B, plate 2), C, and F. Unfortunately B and C became partially dry and even frozen before being placed in the preservative fluid, and the spines appear rather shrivelled. A is a fine piece, although considerably smaller than B and C, and this specimen is made the type of the species (fig. 1, A). Specimens E and H consist of test only, without polypides. The former is a small fragment of a colony growing upon a piece of *Eschara.** Specimen G is a young colony investing a piece of *Retepora* (see p. 52).

Specimen D consists of three young colonies growing upon the same piece of *Menipea.* From the appearance of these one would conclude that either the whole of the polypides of each colony belong to one family, being produced by budding from a single individual which settled in that situation (having itself been produced sexually or as a bud from one of the individuals of a parent colony), or each of the new colonies was formed by a crowd of migrants, a view which is supported by the obviously gregarious character of the polypides of this species in particular. The three colonies appear to be of about the same age, and there is nothing to lead one

* I have to thank Mr. H. W. Burrows for naming the various Polyzoa found in association with the *Cephalodiscus.*

to suspect that one of them is a parent colony of the others. It is further of interest that, although these colonies appear so young and so recently established, there are present, attached to the interior of the test, numerous solitary eggs of oval shape, small size (averaging ·42 by ·47 mm.) and pale yellow colour. They are affixed by a short, fine, transparent pedicle continuous with the thin enveloping membrane.

All the specimens were preserved by being placed in 70 per cent. alcohol.

## *Tubarium.*

The tubarium of this species in its present state, after being in alcohol for three years, is of a light brown colour. It is larger than that of *Cephalodiscus dodecalophus*, has shorter and more closely-set branches, and thicker and longer spines.

The largest piece (fig. 1, B, plate 2) measures about 110 mm. by 70 mm. The original label accompanying this piece is marked "Has been dry." A smaller piece which was dredged at the same time (fig. 1, A), and which in all probability is part of the same colony, is free from this disadvantage, and does not show the shrivelling of the tips of the spines which is apparent in specimen B (as also in C).

The cavity occupied by the polypides is continuous throughout, and branches regularly with the branching of the tubarium. In fig. 22, plate 4, is given a diagrammatic representation of the cavity of the tubarium, as though the polypides had been removed, a cast made of the interior, and the tubarium subsequently stripped off. Sections taken through the stems and branches of the colony are roughly elliptical in shape, and measure about 6 by 4 mm. across. The width of the interior of the tube is from 2 to 4 mm., but it is greater where a branch becomes flattened, as it frequently does towards its free extremity.

The wall of the tube is thinnest in those parts where the test is most regularly tubular, and where there are no spines. The thickness here is not more than ·3 mm. In the basal parts of the colony the tubarium is more massive, and in places attains a thickness of 2 or 3 mm. Although the lumen varies in diameter in the manner described in the preceding paragraph, the inner surface of the tubarium is smooth and even, and is not irregularly chambered as it is in *C. dodecalophus*. There are no internal trabeculae, ridges or partitions; and the cavity is continuous from one end of the colony to the other. The rooted end is, of course, blind, but there are several short branches with ostia close around it.

The terminal branches are short, about 10 to 13 mm. in length, and the portions of the relatively main stem between two consecutive branches are rarely more than 10 mm. in length, frequently much less.

The openings of the tubarium, the ostia, are situated at the terminations of the branches, and are one, two or three in number at the end of each branch. This rule that the openings are terminal is not without exception, but most of the instances of

apparently lateral ostia are explicable on the ground that a lateral branch is in each of these cases in the initial stages of its growth. The openings are oval, sometimes circular, and average between 3 by 2 and 3·5 by 2·5 mm. across. Each opening has four or five spines around its margin. Five representative figures are given of the ostia and their spines, since the number and distribution of the spines of the test of *Cephalodiscus* will probably prove to be among the features useful for distinguishing the various species (figs. 16–20, plate 4).

The spines are simple, or forked, or even trifid. The length of the free part varies considerably, usually within the limits 5 to 15 mm. The width varies from ·6 to 1 mm. The central axis of a spine is darker than the general test, and can be traced for some distance into the latter. The total length of a spine, including this embedded base, varies from 12 to 25 mm. Most of the spines arise from the edges of the ostia.

The successive increments by which the spines are built up remain clearly visible, and a study of the fine dark lines which mark off the different strata shows that the forking of a spine is not due to dichotomy, but that one of the two limbs of the fork is the primary spine and the other one, although it may be equal to it in size, or even greater, has been secondarily attached to its side (see fig. 21, plate 4).

In connection with the probable freedom of locomotion possessed by the polypides of *Cephalodiscus* and the bearing which this freedom has upon the mode of increase of the test, it may be noted here that in specimen C a few pieces of *Flustra* (*Carbasea*) have been caught up among the branches of the colony. In some places the flattened branches of the coenoecium of the polyzoon have been completely buried in the test, but in others the strata of the test are continued along one surface, or along one edge, as a thin film, or as several films, with here and there a spine of the usual structure. This coating of the foreign object extends to a distance of 20 or 30 mm. away from the nearest hollow part of the tubarium occupied by polypides. It seems clear from this that not only have the polypides the power of moving about over the surface of their own test—one cannot conceive how the terminal increments of the spines are put on if they cannot do so—but they are also able to roam about upon neighbouring foreign objects, which they smear over with their profuse secretion.

Specimen C is further of interest in that in certain parts of the colony a stoloniferous polyzoon allied to *Bowerbankia* is found embedded in the test. The relations of the zooids of the polyzoon to the *Cephalodiscus* tubarium are such as to suggest that when they were flooded by the not yet solidified material of the test, they had time to dispose themselves so that their tentaculated ends were flush with the surface before the material hardened. Some of the zooids are normal to the surface of the tubarium, others are oblique, but all have their openings flush with the surface.

In specimen D, as in specimen C, the manner in which the coenoecium of the polyzoon—in this case *Menipea*—has become embedded in the test of the *Cephalodiscus* gives one a good idea of the profusion with which this material is secreted.

The shape of the tubarium of specimen G differs materially from that of the type specimen, but that G belongs to the same species as A is evident from the size of the spines, the size and relations of the few tubular prolongations of the test that can be recognised, the size of the ostia, and the characters of the polypides. Specimen G is evidently a young colony of *Cephalodiscus hodgsoni* which has not yet assumed the racemose appearance presented by the type specimen. The polypides are crowded underneath a square inch or so of the calcified reticular coenoecium of the polyzoon *Retepora*, in relation with which the colony has established itself. They are supported upon a fairly flat floor of test secreted by themselves, and the upper surface of the *Retepora* is also coated with a thin, flat sheet of the same material. From around three-fourths of the edge there stand out fifty or sixty spines, mostly simple and unforked, and radiating more or less obliquely outwards from the centre of the whole structure. Some of these spines are arranged in groups of four or five around the openings of ten or eleven short tubes which lead out from the marginal parts of the flattened central chamber.

This specimen (G) is interesting because Harmer, in describing the species *C. sibogae*, attaches some importance to the crowding of the polypides in a low and wide "basal encrustation" with irregularly divided cavity, set upon the piece of rock on which the colony was growing (**10**, p. 13). That *Cephalodiscus sibogae* is a valid species I do not doubt, but this particular "habit" of the colony will probably prove to be common, in the earlier stages of growth of the colony, to most, if not to all species of *Cephalodiscus*, except those which, like *C. levinseni* and *C. nigrescens*, have separate tubes for each polypide and its buds.

## *Polypides.*

It is remarkable how densely crowded are the polypides in this species; yet, although they are in such close contact, the only organic continuity which exists is that between the parents and their buds. If one side of the tubarium be removed and the contents carefully isolated, the crowd of polypides can be unravelled into a number of separate individuals, with their buds. The apparent connection is due to the entanglement of the stalks of the buds of the different individuals.

Judging from the least crowded parts of the colony it is evident that, as in *C. dodecalophus*, each polypide is free to pass out through the ostia of the tubarium, and to move about from end to end of the interior, except in so far as it may be incommoded by the crowding of the other polypides.

The polypides bear a tolerably close resemblance to those of *C. dodecalophus*, but they are a little larger, measuring 2 mm. from the posterior end of the visceral mass to the front of the buccal shield, and about 2·5 mm. to the ends of the plumes, whereas in *C. dodecalophus* the corresponding measurements are 1·5 and 2 mm. The only colour which the polypides possess is that of the red line of the buccal shield, and the red pigment of the gonad ducts.

The "body" is rather more elongated and less bulbous than that of *C. dodecalophus*, and the stolon arises relatively farther from the shield. The shape of the body is largely determined by the stomach, which is globular and dilated, as in *C. dodecalophus*, and not compressed as it is in *C. nigrescens*. The stolon is distinctly longer and more slender than that of *C. dodecalophus*, and in an average state of contraction measures 2 mm. or less. It is sometimes found curving forwards toward the shield, but if extended it is usually directed parallel with the long axis of the body (see figs. 49 and 50, plate 6). The stolon at its maximum of extension measures 4 mm. or more (fig. 51).

The buds are usually two in number, a large and a small bud, but occasionally as many as four are met with at the end of the same stolon. When a bud remains attached to its parent until it attains a considerable size, it develops a bud of its own.

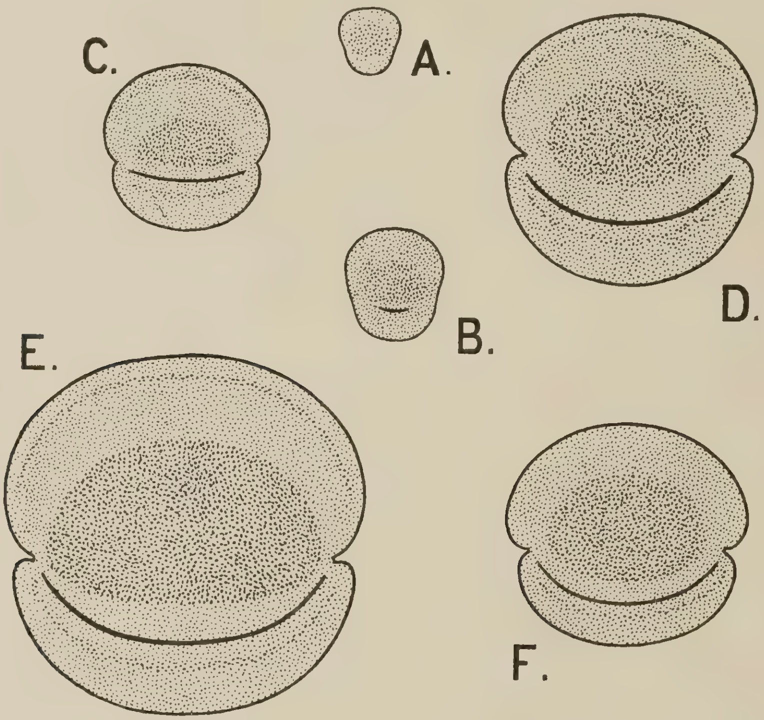
The number of plumes is in the majority of cases twelve. Each plume axis terminates in a bulbous enlargement with refractive beads, particularly in individuals of moderate size only.

One specimen was found having a body shaped like a short sausage, with an extremely slender and elongated stalk arising from one extremity. No plumes, buccal shield, post-oral lamella, mouth, gill-slits nor gonad ducts are to be distinguished (fig. 52). This solitary specimen is of interest in connection with the remark made by Harmer (**10**, p. 93) that in *C. gracilis* the "degeneration of a zooid begins by the throwing off of the proboscis and collar, leaving the metasome, with the alimentary canal, attached to the stalk," and that "degeneration of the zooids is of frequent occurrence, and is usually not succeeded by any regeneration of lost parts." The plumeless polypide of *C. dodecalophus* figured by M'Intosh as an "abnormal specimen" has no stalk (**19**, fig. 4, plate 3).

Most of the polypides are females; two out of the fifty or more specimens examined are hermaphrodite; the rest are males. The sexes of the polypides cannot with certainty be distinguished except by dissection, but as a rule the red pigment of the gonad-ducts is distinctive of the female; at all events it is more strongly marked in the females than in the males. There are no neuters, except perhaps the plumeless polypide mentioned above, the anatomy of which was not worked out. Further details of the plumes, stolon, and gonads, and the characters of the shield, buds, etc., are given under special headings in the pages that follow.

*Buccal Shield.*

The shield of the adult polypide of *C. hodgsoni* varies in size, but on an average of a great many cases measures 1·2 by 1·2 mm. (text-fig. 17, E). The antero-posterior diameter, however, may be as much as ·2 or ·3 mm. longer or shorter than the maximum width, the organ being evidently capable of great contortion in all directions. The posterior lobe is equal in width to the front lobe, or is slightly less; the centre of the red line is about four-fifths or five-sixths of the antero-posterior diameter from the front edge. The diagram given in text-figure 17, E is a composite figure of about twenty specimens.




Text-Figure 17.—A = Buccal shield of a bud of *C. hodgsoni* with two pairs of plume-axes only. B = Shield of a bud with the fourth pair of plume-axes making their appearance as hemispherical projections. C = Shield of a bud with the fifth pair of plume-axes making their appearance as hemispherical projections. D = Shield of a bud with the sixth plume-axes about twice as long as broad, and without pinnules. E = Shield of adult polypide of *C. hodgsoni*. F = Shield of adult polypide of *C. dodecalophus*. These six figures are drawn to the same scale (× 40).

The red line makes its first appearance in the bud at a time when the fourth plume-axes have the form of hemispherical prominences at the base of the third pair. It is at this period only a short line extending across not more than one-third or one-half of the total width of the shield (text-fig. 17, B), and it is in this stage and for some time later relatively more remote from the posterior edge of the shield than it is in the adult (*cf.* text-fig. 17, B, C, D, E); the posterior lobe does not enlarge quite so rapidly as the anterior lobe as growth proceeds. Until the stage at which the fifth pair of plume-axes normally make their appearance—they are in

some cases retarded—the width of the posterior lobe is less than that of the anterior lobe (text-fig. 17, A, B, C).

Except in being somewhat larger, and in that the width of the posterior lobe is a little greater in proportion, the shield does not differ materially from that of *C. dodecalophus.* Text-figure 17, F shows a composite figure made from seven well-expanded shields of the latter species. The width of the front lobe is ·73 to ·83 mm., and that of the hind lobe rather less. The centre of the red line is ·60 to ·66 mm. from the front edge, and ·11 to ·16 mm. from the hind edge, the average antero-posterior diameter being ·77 mm. In young buds the red line is relatively farther forward than in the adult polypide, as in *C. hodgsoni.*

### *Plumes.*

The normal number of plumes is twelve, but the sixth pair develop late, and a full-sized polypide, with buds of its own, and with well-developed ovaries, may have only ten fully-grown plumes. Close inspection, however, usually reveals the presence in such polypides of a sixth pair, these being very small outgrowths, with no pinnules, situated at the most anterior part of the line of attachment of the post-oral lamella to the rest of the body. The late-developed sixth plumes of such individuals are rarely exactly equal in size; it almost always happens that one is larger than the other. No polypide of *C. hodgsoni* has been found possessing more than twelve plumes.

The plumes bear a fairly close resemblance to those of *C. dodecalophus.* Each consists of an axis, about 1·5 mm. long when well extended, with a central coelomic space continuous with the collar cavity, with a hollow end-bulb with high epithelial cells, and with pinnules arranged in two lateral series (figs. 31 and 32, plate 5). The axis is flattened, and grooved along the surface more remote from the central nervous system, and the pinnules, which usually number thirty, sometimes as many as forty, along each edge are not merely attached to the edge of the axis, but are continued across the groove almost to the median line. The pinnules of one side as they become free from the edge of the axis are not set exactly in one plane, but they alternate slightly, so that when a plume is laid flat on a glass slip under the microscope, the pinnule bases will not be all in focus at the same time. Assuming that the pinnules are denoted by consecutive numbers along one edge, those bearing odd numbers will be out of focus when those bearing even numbers are clearly defined, and *vice versâ.*

The base of each pinnule is enlarged, and this is especially noticeable if the plumes are in a state of contraction. New pinnules are produced at the base of the plume-axis for a considerable time after the bud has become separated as a free polypide, if not for the whole life of the polypide; a few small basal pinnules in graduated series are almost invariably to be found. All

pinnules except the few youngest at the base of the plume-axis are slightly swollen at their extremities. The most distal pair of pinnules arise as a rule immediately to the proximal side of the end-bulb, and are comparatively short (figs. 33–35, plate 5); exceptionally they arise from the end-bulb itself (fig. 36). The longest pinnules vary from ·5 to ·7 mm in length in different individuals.

The bulb at the extremity of the plume-axis of *C. dodecalophus* is a hollow enlargement, of the shape of two-thirds of a sphere, and with a wall composed of taller epithelial cells than those of the plume-axis. The cavity is continuous with that of the plume-axis, and is traversed by a few coelomic trabeculae. These end-bulbs have been described in detail by Masterman (**22**, p. 344, and **24**, pp. 516 and 521) and Cole (**2**). The former author regarded the terminal swelling of the plume as a rudimentary monostichous compound eye, bearing a remarkable resemblance, both in appearance and structure, to the "branchial organs" found in the sedentary Annelids, such as *Potamilla* and *Sabella*, but he states in a later paper (**28**, p. 725) that he had already abandoned this view before the publication of the observations of Cole, who considers the terminal bulb to be a "rhabdite-battery," composed of rhabdite "cells" resembling those of Turbellaria and Nemerteans.

Harmer (**10**, p. 38) states that end-bulbs with highly refringent vesicles, similar to those of *C. dodecalophus,* occur in the buds of *C. gracilis* on the first pair of plumes, sometimes also on the second and third (p. 20 and p. 94), and that these vesicles probably disappear as the adult stage is reached. No end-bulbs or refringent vesicles occur in *C. levinseni*, nor in neuter individuals of *C. sibogae*, but the males of *C. sibogae* have two long arms, representing the first pair of plume-axes without pinnules, and these have closely-set refringent vesicles covering the greater portion of their length. On page 90 he suggests, with some diffidence, that possibly the vesicles "have the nature of reserve supplies of nutritive material, developed precociously in the young bud for the nutrition of the future testes."

The end-bulbs of *C. hodgsoni* are less truly spherical in their curvature than are those of *C. dodecalophus,* since the tall epithelium extends farther along the neural than the grooved face of the plume-axis, and thus present a lop-sided appearance when examined from the side (figs. 33 and 35, and text-fig. 1). The clear refractive beads of previous authors occur among the tall cells of the end-bulb, and are present in greater profusion in immature than in full-grown polypides.

A minute examination of thin sections and of teased preparations suggests the possibility of the refringent vesicles of Harmer and the rhabdite "cells" of Cole being the globules of the tubarium of the colony in process of secretion, like the globules of mucus in the goblet-cells of a mucous membrane. When the secretion is forming, it is of course, surrounded by protoplasm, and if the bead of secreted material is large, it will bulge upon the surface, being covered by a thin pellicle

only of the protoplasm. On the pellicle breaking, the secretion will flow over the surface of any solid body to which that particular part of the epidermis of the end-bulb is applied, and subsequently solidify as a film. If, however, the animal is killed before the pellicle breaks, the secretion hardens as a clear bead, projecting to a greater or less extent above the general surface of the epithelium (figs. 33–36). I have not recognised any rhabdites in these beads in either *C. hodgsoni* or *C. dodecalophus.*

The refractive beads are not confined to the end-bulbs. Small ones are mostly to be found at the ends of the pinnules, and others, not smaller than those of the end-bulb, may sometimes be seen along the neural face of the plume-axis. More rarely they are to be found in the whole of the epidermis of the body-wall (e.g. in the plumeless polypide referred to above, fig. 52, plate 6). Assuming that these are the cells of the epidermis secreting the test, the inconstancy in their occurrence elsewhere than in the end-bulbs may be accounted for by the relative activity or quietude of the polypide in respect of secretion of test at the time of death.

### *Post-oral Lamella.*

The post-oral lamella does not differ materially from that of *C. dodecalophus.* It may be described as consisting of a pair of lateral flaps of the body, containing an extension of the collar coelom, situated at the sides of the mouth, and connected behind the mouth by a narrow band which has a free posterior border continuous with the free edges of the lateral flaps, but differing from the latter in not being thickened (fig. 53, plate 6). The post-oral lamella becomes free from the body around the edge of the part which in fig. 53 is shaded by irregular lines, and in the middle of which the mouth is situated. The ragged front edge of the shaded area marks the position of the hinder surface of the stalk of the buccal shield. The base of the sixth plume-axis occurs in development at the anterior limit of the attachment of the lateral flap, and in continuity with it.

### *Gonads.*

The sexes of the polypides of *Cephalodiscus hodgsoni* are in most cases distinct, though not invariably so. Two hermaphrodite polypides, each with one ovary and one testis, were discovered among the many polypides dissected.

Most of the polypides are females. The ovaries, when fully mature, are ovoid or pyriform bodies, measuring ·8 by ·5 mm. (fig. 42, plate 5). The oviducts are of a brilliant red colour. In some young ovaries the oviduct is larger than the ovary itself (fig. 43), and the transition from the red oviduct to the white ovary is abrupt (figs. 43 and 46). In other young ovaries the red pigmentation spreads in an irregular and diffuse manner into the interior of the ovary (figs. 44 and 45).

The testes, when fully formed, are slightly larger than the ovaries, and measure ·9 by ·6 mm., or, if less elongated, ·83 by ·75 mm., and the ducts are as a rule not coloured red, and are shorter and narrower than the oviducts. The shape of the testis is ovoid or pyriform (fig. 41), and there is no tendency to elongation, as there is in the testes of *C. sibogae* (**10**, p. 85) and *C. nigrescens* (fig. 37).

The males and females differ only in respect of their gonads and ducts, and possess no secondary sexual characters. They occur mixed up in the same agglutinated crowd in the internal cavities of the tubarium. The buds are not necessarily of the same sex as their parent. One of the male polypides of specimen F was found to possess a bud with a pair of fairly large ovaries.

The specimens of *C. hodgsoni* dredged by the 'Discovery' were not all obtained from the same situation, nor at the same time of year, and some of the differences in the state of the gonads may possibly be attributable to seasonal changes. The condition of the gonads in the various specimens is as follows:—

In specimens A and B the majority of the polypides are females with small ovaries. A few are males with comparatively large testes (·86 by ·67 mm.) and colourless ducts. Two polypides were found in which both testes had red ducts, and in these two specimens one testis was large and the other small. One polypide was found with a large testis and a small ovary, both with red ducts (fig. 47). It is worthy of remark that no ripe ovaries are present in specimens A and B.

In specimen C the numbers of male and female polypides are about equal. The females are on the whole less mature than the males, and their gonads are in some cases very small. One hermaphrodite polypide was found, possessing a large testis and a small ovary. No testis ducts of material C exhibit any red colour.

It is only in specimen D of *C. hodgsoni* that free ova are found. They occur singly, they are pale yellow in colour, and ovoid in shape (fig. 48), they measure about ·47 by ·42 mm., and are attached by a narrow pedicle to the inner surface of the tubarium. Of fourteen polypides examined thirteen were female and one was male. Some of the females have fully developed ovaries, with red ducts, and also with red spots in the interior of the ovary; other polypides, of the same size as the former, have minute ovaries with no red colour in the oviducts, nor in the ovaries. The single male found has two large testes, one of which has a red duct.

In specimen F female polypides are commoner than male, and less mature. In the least mature females the ovarian part of the generative apparatus is small as compared with the size of the red oviduct (figs. 43 and 46). The largest ovary found measures ·5 by ·45 mm., not including the duct, and the testes of the males measure ·8 by ·75 or ·83 by ·7 mm. The testis ducts are narrower than the oviducts, and are not red.

In specimen G all the polypides examined are very immature females; the ovaries are extremely small, about ·05 mm. in greatest width, and ·1 mm. long, including

the duct, which has no red colour, or but a few red specks here and there. The ovaries consist of small closely-packed cells with one larger cell, perhaps two, exhibiting a germinal vesicle and germinal spot, just enough to enable one to distinguish the sex.

The polypides of material G are of the full size distinctive of the species, and have buds of their own, and the smallness of the ovaries is noteworthy, because in specimen F the ovaries are fairly well developed in buds of not more than half the size of the adult polypides. Specimen G was obtained in May, whereas all the other specimens collected (except specimen H, which has no polypides) were obtained in January. The colony, further, has the general appearance of being but recently established (vide p. 52), and this circumstance, taken in conjunction with the above, warrants the suggestion that the full-sized polypides of G arrived at their present situation as free-swimming larvae, and were not produced by the budding of their parents.

### *Stolon and Budding.*

The stolon of most of the full-grown polypides is about 2 mm. long, but the wrinkling of the surface indicates that the organ was fixed by the killing reagent in a state of contraction. Exceptionally one finds a long stolon, four or five millimetres long, with less superficial wrinkling. In old buds the stolon is frequently curved strongly towards the shield, but in adults it usually slopes rather away from the shield; in cases in which the stolon is in exceptional extension it is parallel with the long axis of the body (fig. 51, plate 6).

Although there is ample evidence that the customary method of separation of a bud from its parent is by the severance of the tissue between the end of the stalk of the bud and the extremity of the stolon of the parent, yet in examining bud-systems of *C. hodgsoni* one not infrequently meets with curved, sausage-shaped or banana-shaped structures which give one the impression of being portions of parental stolon which have become severed close to the body, or at some point along the course of the stolon, or else the stalks of buds similarly divided.

Harmer in his 'Siboga' report regards the sausage-shaped bodies as the stolons of adults which have died off, or "degenerated," as he puts it. While this may be the case in the species of *Cephalodiscus* examined by him, the specimens of *C. hodgsoni* figured in plate 7 would seem to show that the parent body is in a perfectly healthy condition at the time when this severance takes place, especially as buds not fully grown may separate off by constriction of their stalk at any point of its length at a time when the parent stolon is still perfect.

In figs. 78, 79, and 81, plate 7, are shown bud-systems unconnected with any parent form. The first of these is composed of four buds and a curved sausage-like body which is presumably the parental stolon which has become severed close to the parental body, the separation between buds and parent occurring in this case not at

the distal end of the parental stolon. In fig. 81 the large individual is a half-grown bud, and the sausage-shaped structure is no larger than the stalk of the former, and bears a small bud of exactly the same size as that borne by the extremity of the stalk of the large bud. Further, there is an indication of a constriction at the basal end of the stalk of the large bud, which if completed would convert the stalk into a sausage-like structure exactly similar to that shown on the right side of the figure. One concludes, therefore, that the latter body is the severed stalk of a half-grown bud.

In fig. 79 there are two sausage-like bodies and three buds, two on the larger, and a very small bud on the smaller. Fig. 83 shows a long curved, club-shaped rod, and two buds, one with the fifth pair of plumes just appearing, the second with the first plumes only, still attached to the extremity of the stolon of a normal and healthy individual, not shown in the figure. The area from which the parent stolon was dissected off is marked *a*. In this case it is fairly evident that the club is a bud-stalk.

While groups such as are shown in figs. 78, 79, and 81 are not uncommon, the groups which afford the evidence of the mode of origin of the sausage-like bodies are scarce. In fig. 82 is shown a parent individual with a constriction of the stolon in such a position that, if intensified so as to result in a division of the stolon, it will leave in the bud-system a curved, sausage-like body such as that shown in figs. 78 and 79. The group shown in fig. 80 differs from the last in that the basal portion of the parental stolon is attenuated and narrow, and is of interest as suggesting the mode of origin of such a group as that shown in fig. 77, in which, while there is a sausage-like body, less curved than usual, attached to the two buds, it is but the terminal portion of a moniliform rod, the free end of which is pointed.

The group shown in fig. 76 is interesting because the parent individual and its stolon are still perfect, and yet there is a half-grown bud in process of severing its stalk at about the middle of its length, and a curved, club-shaped body which presumably represents the whole, or the distal part, of the stalk of a bud which has previously cut itself off from the group.

Only rarely is such a complex system as that shown in fig. 84 met with. In this case it would appear that *a* is the severed stolon of the parent polypide of the group; *b*, the largest individual present, is nearly full-grown, and has two buds of its own, *c* and *d*; the bud *e* has a bud of its own, *f*; but what are the relations of the buds *g*, *h* and *j* is not clear. The small size of *j* rather casts a doubt upon the identification of *a* as the stolon of the main individual of the group, and yet *a* is thicker than the stalk of *b*, and *b* is not yet fully grown.

Notwithstanding the difficulty of interpretation of the last group, one may conclude that in general the parent polypide produces from the margin of the flattened extremity of its stolon first one bud and then a second. The first bud develops from the side of the distal extremity of its stalk a bud of its own, and then,

when nearly of full size, separates from the parent by severance at the distal end of its stalk from the end of the parent stolon, and is now in the position of the parent individual referred to in the beginning of this paragraph. Sometimes the parting from the parent individual is delayed until the seceding bud has developed a second bud of its own.

What happens to the parent polypide when its two buds have departed can hardly be determined except by tracing the process of budding in a living colony. Possibly it produces young buds at the same rate as the old buds separate off, so that the number of buds on the parent stolon is maintained at two. If this be so, there is less reason for doubting that *a* in fig. 84 is the parent stolon, and *j* its recently formed bud.

What are the conditions which determine whether or no a parent stolon or a bud-stalk shall constrict and divide at its middle, or at its proximal end, are difficult to conceive. The acceptance of Harmer's view that the individuals so liberated are "degenerated" is hardly possible in view of the healthy appearance of the polypides shown in figs. 80 and 82; yet what became of the stolonless polypides and stalkless buds after their separation by this method is a mystery, for no such individuals have been encountered in the course of the investigation. Since in the whole animal kingdom it is so very unusual for sexual reproduction and vegetative reproduction to take place simultaneously in the same body, may one conjecture that sexually reproducing polypides first cast off their vegetatively produced families, together with the gemmation-tissue of the stolon, and become more free-living in their habits, perhaps leaving the colony altogether? This explanation would account for the absence of stolonless polypides in the mass of individuals taken from the cavities of the tubarium.

That the constriction and division of parent stolons and bud-stalks is due to the convulsive contraction of certain parts of the concentric muscles at the time of death, is rather negatived by the perfect rounding off of the free ends of the sausage-like structures, and by the absence of stolonless polypides in the material examined. Further than this, in *C. nigrescens*, the sausage-shaped piece of stalk is sometimes found with buds at its free end as well as at its basal end (figs. 69, 71 and 73).

### *Buds.*

The bud on its first appearance is ellipsoidal or ovoidal in shape (fig. 54, plate 6). The attached end becomes narrower, and the free end becomes flattened dorso-ventrally into what will later be the anterior part of the buccal shield. The posterior edge of the buccal shield next becomes marked out by the appearance of a curved groove, situated about halfway along the ventral surface of the bud, and, at the same time, the first pair of plume-axes develop as hemispherical swellings on the dorsal surface (fig. 55). The buccal shield enlarges in all directions, and

the posterior lobe grows backward and downward; it is thinner than the anterior part of the shield, and maintains this relation throughout life.

By the time the shield is so far differentiated as to possess a stalk or pedicle attached to the middle of its dorsal surface, the "body" or metasome is pear-shaped, and a second pair (fig. 56), and third, and fourth (fig. 57) pairs of plume-axes make their appearance. The bud is at this time capable of remarkable change of form, and an eight-plume bud may show a long "body" and stalk, and a cupped shield with an obvious pedicle (fig. 58), or, more usually, a flattened shield, attached at its middle, but with no clear pedicle, and a short and wrinkled "body" and stalk (fig. 57). As a rule, buds that have reached the same stage of development, so far as can be judged by the number of plumes present, are of approximately the same size, but it is to be noted that the eight-plume bud shown in fig. 58 is exceptionally large.

The red line of the buccal shield begins to appear at about the stage when the fourth pair of plume-axes are hemispherical knobs only, or are losing their hemispherical shape and are becoming elongated (text-fig. 17, B, p. 54).

## SUMMARY OF RESULTS.

1. A new species of *Cephalodiscus* (*C. hodgsoni*) is placed on record (p. 3), and descriptions are given of the two species obtained by the 'Discovery,' namely, *C. nigrescens* and *C. hodgsoni* (pp. 20–49 and pp. 49–62).

2. A new sub-generic name *Idiothecia* is given for the inclusion of those species of *Cephalodiscus* (*e.g.* *C. nigrescens* and *C. levinseni*) in which the polypides reside in separate tubular cavities in the tubarium (p. 7), and the sub-generic name *Demiothecia* for those species in which the polypides live together in the same cavity.

3. A review is given of the six recorded species of *Cephalodiscus*, namely, *dodecalophus*, *hodgsoni*, *gracilis*, *sibogae*, *nigrescens* and *levinseni* (pp. 7–11), also a key to the identification of these (pp. 11–12).

4. Since the tubes of the tubarium of *C. nigrescens* are entirely separated and show no signs of having been continuous at an earlier stage of development, a suggestion is offered as to the behaviour of the polypides in the building up of the tubarium (p. 23).

5. Descriptions and semi-diagrammatic figures are given of sections of the polypides of *C. nigrescens* taken through structures of particular interest (pp. 34–41).

6. The "problematical body" of Harmer, supposed by that author to consist of lamellae, probably of a muscular nature, is shown in the case of *C. nigrescens* to be formed, not of lamellae, but of obliquely interlacing cross-striped muscle fibres (pp. 41–43).

7. In both of the new species obtained by the 'Discovery' there are hermaphrodite individuals, with one ovary and one testis, as well as males and

females with two testes and two ovaries respectively. There is no sexual dimorphism such as occurs in the case of *C. sibogae* (Harmer); the three kinds of polypides—males, females and hermaphrodites—are indistinguishable externally, except in so far as the ducts of the testes do not as a rule possess the red pigment that occurs in the oviducts (pp. 45–47 and pp. 57–59).

8. The mode of development of the buds of *C. nigrescens* and *C. hodgsoni* is considered (pp. 47–49 and pp. 59–62).

9. The clear refractive beads found in the end bulbs of the plumes of *C. hodgsoni* are regarded, not as rhabdite-cells, but as the material of the tubarium in process of secretion, after the manner of the globules of mucus in a goblet-cell (pp. 56–57).

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# EXPLANATION OF THE PLATES.

## PLATE 1.

Photograph of *Cephalodiscus* (*Idiothecia*) *nigrescens*; natural size. (From Lankester, **15**.)

## PLATE 2.

Fig. 1.—Photographic reproduction of *Cephalodiscus* (*Demiothecia*) *hodgsoni*; natural size. A, small perfect specimen; B, larger specimen with the tips of the spines shrivelled, owing to drying.

Fig. 2.—Photograph of a massive colony of *Cephalodiscus* (*Idiothecia*) *nigrescens*; natural size.

## PLATE 3.

Fig. 3.—*Cephalodiscus* (*Idiothecia*) *nigrescens*, drawing of a branch as seen against a white background. (× $1\frac{1}{2}$.)

Fig. 4.—Median longitudinal section of same. (× $1\frac{1}{2}$.) In figs. 3 and 4 the black parts are the polypides seen through the transparent test; the small white ovals are free ova in the tubes.

Fig. 5.—Drawing of an older branch. (× $1\frac{1}{2}$.) *a*, *b*, *c*, scars left by fallen branches.

Fig. 6.—Transverse section of a branch. (× $1\frac{1}{2}$.)

Fig. 7.—A polypide of *Cephalodiscus nigrescens* as it appears on removal from its tube. (× 13.) *b*.1, bud flattened against the ventral side of the polypide; *b*.2, bud flattened against the far side of the polypide; *b*.3, five other buds; *b.s.*, buccal shield; *go.*, gonad; *pl.*, plumes; *st.*, stolon; *v.m.*, visceral mass.

Fig. 8.—A polypide of *C. nigrescens* with plumes more expanded and with the buds disentangled. (× 13.) *b.*, buds; other letters as in fig. 7. Figs. 7 and 8 were drawn under a Greenough binocular microscope, with a strong top illumination; the polypides do not look as black as they would if the illumination had been less intense.

Fig. 9.—Cells of the pigmented epithelium as they appear when teased out and examined in dilute glycerine.

## PLATE 4.

Fig. 10.—Diagram of a longitudinal section of the distal half of a branch of *Cephalodiscus* (*Idiothecia nigrescens*) showing the relative lengths and curvatures of the various tubes. (× 2.) In this diagram the whole of the tubes visible are represented as lying wholly in the radial plane; as a matter of fact the inner ends of the tubes twist about one another in the axial part of the branch (see fig. 4, pl. 3) The polypides are not shown.

Fig. 11.—Diagram of one of the tubes of *C. nigrescens*, with a contracted polypide within, showing the form of the lip of the tube and the hemispherical septa at the blind end. The ragged edge of the figure represents the irregular surface left after picking away the adjacent tubes. (× 8.)

Fig. 12.—Longitudinal section of the mouth of a tube of *C. nigrescens* taken through the middle of the lip, showing the mode of deposition of the layers of the test. (× 15.)

Fig. 13.—The distal end of a long uninhabited tube, dissected out and cut longitudinally. Note the six irregular closing septa, and the close-set superficial layers of common soft test burying the mouth of the tube. (× 15.)

Fig. 14.—Polypide of *C. nigrescens* found free, *i.e.*, not in a tube. The buds have been cut away. (× 14.)

Fig. 15.—A polypide of *C. nigrescens* taken from one of the short terminal tubes of the branch. (× 11.) In figs. 14 and 15 the blackness of the polypides has been reduced in order to show the shape of the body; were this not done the body would appear almost as a silhouette.

FIGS. 16, 17, 18, 19, 20.—Views of the ostia and spines of *Cephalodiscus* (*Demiothecia*) *hodgsoni*. Many of the spines are standing out obliquely towards the observer. Nat. size.

FIG. 21.—A forked spine of *C. hodgsoni* showing the mode of growth. (× 7.)

FIG. 22.—Diagrammatic representation of the cavity of the tubarium of *C. hodgsoni*, as though the polypides had been removed, a cast made of the interior, and the test subsequently stripped off. Nat. size.

## PLATE 5.

FIG. 23—A flattened plume of *Cephalodiscus* (*Idiothecia*) *nigrescens* in moderate contraction, seen from the central (neural) aspect. Note the rounded extremity of the axis. (× 50.)

FIG. 24.—A plume in moderate extension. Note the pointed extremity of the axis. (× 50.)

FIG. 25.—Usual aspect presented by contracted plumes, when seen from the side. (× 50.)

FIG. 26.—Another plume seen from the side, with the axis less strongly curved. (× 50.)

FIG. 27.—Another plume in side view. Note that in this plume, apparently fully-grown, the pinnules are few, and the distal ones project beyond the extremity of the axis, whereas in the plumes shown in figs. 25 and 26 they fall considerably short of it. (× 50.)

FIG. 28.—Transverse section of a plume-axis of *C. nigrescens* taken at about one-third of its length from the free end. (× 160.) *b.v.*, blood-vessel; *c.e.*, ciliated epithelium; *m.*, muscle; *n.t.*, nerve tract; *p.e.*, pigmented epithelium; *s.k.*, skeletal layer.

FIG. 29.—Transverse section of a pinnule of *C. nigrescens*. (× 420.)

FIG. 30.—A similar section passing through a pigmented cell. (× 420.)

FIG. 31.—A plume of *Cephalodiscus* (*Demiothecia*) *hodgsoni* seen from the side. (× 40.) The pinnules of the farther side are not shown.

FIG. 32.—A plume of *C. hodgsoni* seen from the aponeural aspect. (× 40.)

FIGS. 33, 34, 35, 36.—Terminal portions of plumes of *C. hodgsoni* in optical section, showing the refractive globules projecting beyond the surface of the terminal bulb. (× 140.) Note that in fig. 36 the most distal pinnule arises from the end-bulb itself, whereas more usually it arises from the neck of the bulb.

FIG. 37.—Testis of *Cephalodiscus nigrescens* dissected out and viewed as a solid object by reflected light. (× 50.)

FIGS. 38, 39, 40.—Ovaries of *C. nigrescens* dissected out and viewed by transmitted light after mounting in diluted glycerine. (× 50.)

FIG. 41.—Testis of *Cephalodiscus hodgsoni* as seen by transmitted light after mounting in diluted glycerine. (× 40.)

FIG. 42.—Ovary of *C. hodgsoni* by transmitted light. (× 40.) This was the largest ovary found. The relative opacity of the two largest ova is due to yolk.

FIGS. 43, 44, 45, 46.—Ovaries of *C. hodgsoni* showing differences in the distribution of the red pigment. (× 40.)

FIG. 47.—The ovary and testis of a hermaphrodite polypide of *C. hodgsoni*. (× 40.) Note that the testis duct has red pigment, which is exceptional. (*cf.* fig. 41.)

## PLATE 6.

FIG. 48.—Egg of *Cephalodiscus* (*Demiothecia*) *hodgsoni*. (× 40.)

FIG. 49.—Polypide of *C. hodgsoni* seen from the side. (× 28.) Letters as in fig. 7, pl. 3.

FIG. 50.—A polypide of *C. hodgsoni* with longer stolon than the last, and a flatter shield: ventral view. (× 28.)

FIG. 51.—Side view of a polypide of *C. hodgsoni* with a well-extended stolon. (× 28.)

FIG. 52.—A long-stalked plumeless polypide of *C. hodgsoni*. (× 16.)

FIG. 53.—The post-oral lamella of a polypide of *C. hodgsoni* dissected off and flattened out; dorsal view. (× 40.)

FIG. 54.—Young bud of *C. hodgsoni*. (× 60.)

FIG. 55.—Later bud, with first pair of plume-axes appearing; dorsal view. (× 60.)

FIG. 56.—Later bud, with second pair of plume-axes appearing; side view. (× 60.)

FIG. 57.—Later bud, with fourth pair of plume-axes appearing; dorsal view. (× 60.)

FIG. 58.—Bud of same stage of development as the last, but in a state of considerable extension; side view. (× 60.)

FIG. 59.—A late or "ripe" bud of *C. hodgsoni*, with a small bud of its own. (× 30.) As in figs. 54–58, the parent stolon from which the bud was dissected off is not shown.

## PLATE 7.

FIG. 60.—Young bud of *Cephalodiscus* (*Idiothecia*) *nigrescens*. (× 30.)

FIG. 61.—Later bud of *C. nigrescens*; ventral view. (× 30.)

FIG. 62.—Later bud; ventral view. (× 30.)

FIG. 63.—Later bud; ventral view. (× 30.)

FIG. 64.—Bud of same stage as that shown in fig. 63; side view. (× 30.)

FIG. 65.—Similar bud in side view, but showing a very common disposition of the buccal shield. (× 30.)

FIG. 66.—Later bud of *C. nigrescens*, dorsal view, at a stage when the fifth pair of plumes are just appearing. (× 30.) Letters as in fig. 67.

FIG. 67.—Later bud of *C. nigrescens*. (× 30.) Pinnules are appearing upon the plume-axes, and the bud has already developed two buds of its own. *a*, area of attachment to the parent stolon; *b.*, buds; *b.s.*, buccal shield; *pl.*, plumes; *v.m.*, visceral mass or "body."

FIG. 68.—Late bud of *C. nigrescens*, almost ripe. (× 30.) The axes of the plumes are now thickened, and the visceral mass projects in such a way that the stolon is no longer terminal. This stage is rare. The specimen figured had no buds of its own. *st.*, stolon; other letters as in fig. 67.

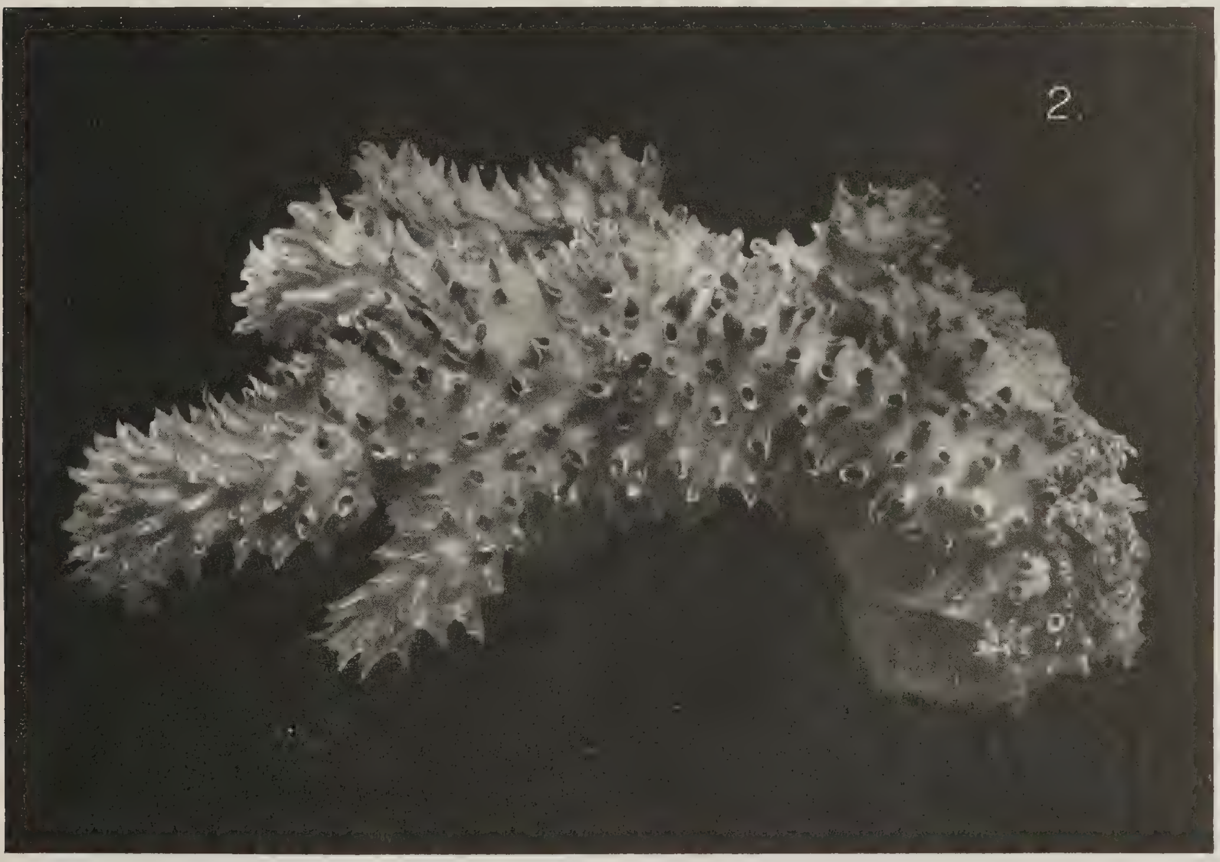
FIGS. 69–75.—Budding systems of *Cephalodiscus nigrescens*. In figs. 69–73 the distal end of the parental stolon is shown from the side, the cut surface being uppermost in the figure; figs. 74 and 75 show the end view of the parental stolon. Only the smallest buds are shown entire; in other cases the bases of the stalks alone are shown. All magnified about 15 diameters. For explanation of letters of fig. 73 see text, p. 48.

FIGS. 76–84.—Budding systems of *Cephalodiscus* (*Demiothecia*) *hodgsoni*. All magnified about 12–15 diameters. In fig. 76, *st.*, terminal portion of parent stolon. In fig. 83, *a*, area of attachment to parent stolon. For lettering of fig. 84 see text, p. 60.

Antarctic (Discovery) Exp.

Butterworth photo. et sculp.

CEPHALODISCUS NIGRESCENS.


Antarctic (Discovery) Exp.

Butterworth photo. et sculp.

CEPHALODISCUS HODGSONI (Fig. 1.) CEPHALODISCUS NIGRESCENS (Fig. 2.)

Plate 3


G.M.W. del

Antarctic (Discovery) Exp.

Lith. Werner & Winter, Frankfort a/M.

CEPHALODISCUS NIGRESCENS.


Antarctic (Discovery) Exp.

W.G.R. del. Huth sc.et imp

CEPHALODISCUS NIGRESCENS (Figs 10-15). CEPHALODISCUS HODGSONI (Figs. 16-22)

Plate 5


Antarctic (Discovery) Exp

W G R. del. Huth sc et imp

CEPHALODISCUS NIGRESCENS. (Figs. 23-30 & 37-40), CEPHALODISCUS HODGSONI. (Figs. 31-36 & 41-47)


Antarctic (Discovery) Exp.

W. G. R. del. Huth sc. et imp.

CEPHALODISCUS HODGSONI.


Antarctic (Discovery) Exp.

W. G. R. del.

CEPHALODISCUS NIGRESCENS (Figs. 60-75), CEPHALODISCUS HODGSONI (Figs. 76-84).

# MOLLUSCA.

## I.—CEPHALOPODA.

By W. E. Hoyle, M.A., D.Sc., The University, Manchester.

The collection of Cephalopoda brought home by the 'Discovery' consists of a number of mandibles, many in a fragmentary condition, obtained from the stomachs of seals and penguins, and one larval form. Apparently no special efforts were made to collect these animals, for though the group does not seem to be richly represented in the Antarctic regions, other expeditions have brought home larger numbers.

### MANDIBLES.

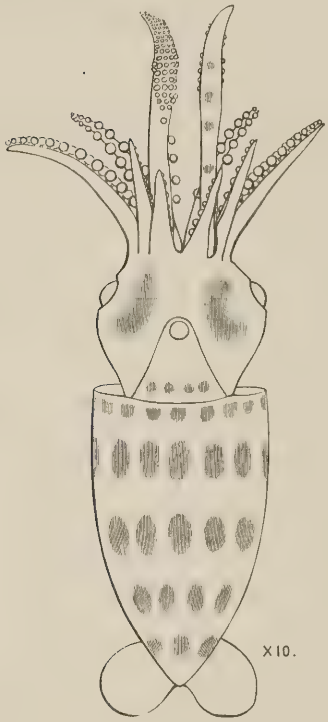
The specimens of mandibles are as follows:—(1) Stomach of Emperor Penguin, January 4, 1902 [H 1350]. Nineteen upper mandibles, apparently all belonging to the same species. Eleven lower mandibles, all of one species, and most probably belonging to the upper mandibles just mentioned. One upper mandible, apparently of a different species, but only fragmentary. I have not succeeded in determining the systematic position of any of these, further than that they probably belong to the Decapoda. (2) Stomach of *Lobodon carcinophaga* Second [H 1349]. Three fragments probably of the same species as the nineteen mentioned above. (3) Stomach of Weddell's Seal, W.Q., July 24, 1902 [H 1351]. Three upper mandibles of different sizes, and belonging to two, possibly three, species. The smallest is an Octopod, the two larger Decapods. There is also a lower mandible, which appears to belong to the middle-sized upper one. (4) Stomach of Seal, ♂, November 10, 1902, Hut Point, W.Q., 54° 01¼′ S., 170° 49′ E. [H 1346]. A pair of moderate-sized mandibles, probably belonging to an Octopod a couple of feet in total length. A pair of somewhat similar mandibles, rather smaller, and probably belonging to a different species. The difference in form is small, but the extent of variation of these organs within the limits of a species is not yet known [H 1347]. A few fragments of very doubtful position [H 1348].

### LARVAL HISTIOTEUTHID.

December 27, 1901; Lat. 54° 01¼′ S.; long. 170° 49′ E. [H 1345].

My friend Dr. G. Pfeffer has very kindly examined this young specimen, and has favoured me with some notes upon it, a translation of which is here appended:

"The young Cephalopod submitted to me is a larval *Calliteuthis.* That it belongs to the Histioteuthidæ is probable at the first glance, from its general appearance, and examination with a lens converted the suspicion into certainty. The peculiar form of the body and fins, as well as the lack of a sinus in the ocular opening, and the strong pigmentation occur only in this manner in the young of Enoploteuthidæ and Histioteuthidæ. The numerous rows of suckers on the tentacular club and their prolongation down the stem of the tentacle show that it cannot be an Enoploteuthid.


×10.

"It must be admitted that the characteristic development of luminous organs is not yet shown, but closer investigation would probably show the rudiments of them. The smallest specimen (with a mantle-length of 6 mm.) in my possession already possesses them; but I believe Professor Chun has a still smaller one in which they are not yet visible.

"Other characters which show the specimen to be a Histioteuthid are the relatively broad funnel cartilages, the form and comparative size of the suckers, especially their relatively small size on the ventral arms.

"Finally it may be shown by a process of exclusion that it cannot belong to any other family. The Bathyteuthidæ have fins of quite different shape, no suckers on the tentacular stem, and much smaller ones on the club; young specimens have quite a different appearance.

"The Gonatidæ have more than two rows of suckers on the arms.

"The Tracheloteuthidæ are essentially different in form and have much smaller suckers on the tentacles; in addition to which, the terminal cone of the pen is clearly visible through the integument, and finally the young of this family are slender, colourless and ghost-like.

"Young Architeuthidæ have not yet been seen by me, nor, so far as I am aware, by anyone else; they must, however, be quite different from the specimen now under consideration."

I removed a portion of the mantle and had a series of sections prepared, hoping to find traces of the luminous organs in an early stage of development. I was, however, unable to find any structures which could be so interpreted.

# MOLLUSCA.

## II.—GASTROPODA.

By Edgar A. Smith, I.S.O.

(Plates I. and II.*)

Altogether twenty-six species of Gastropods (exclusive of a few Nudibranchs and some Pteropods) and fourteen Lamellibranchs were obtained by the Expedition, Three-fourths of these appear to be new. The majority of them are small and insignificant, but among the rest are a few striking forms, notably the new genus *Trichoconcha*, a very remarkable Chiton, the *Trophon longstaffi*, and a beautifully sculptured *Lima*. A glance at the collection at once suggests that it was obtained either in deep water or a cold climate, for the almost total absence of colour in nearly every instance is characteristic. It does not show any particular resemblance to the Arctic fauna; indeed, the majority of the genera have almost a world-wide distribution. The genus *Trophon*, for instance, although typically a northern and Antarctic group, has a characteristic representative in *T. carduelis* of Watson, which occurs off Sydney in 410 fathoms; and it will probably eventually be shown that many genera, which are usually regarded as peculiarly Arctic, have a much wider range than has been anticipated, although they may occur at much greater depths than in northern latitudes. Of the previously described species recorded in the following pages nearly all are known from Kerguelen Island, and possibly most of the remainder may also occur there. Only a single species was collected which was obtained by the 'Belgica.'

### Neobuccinum eatoni.

*Buccinopsis eatoni*, Smith, Ann. Mag. Nat. Hist., Vol. XVI., 1875, p. 68.
*Neobuccinum eatoni*, Smith, Phil. Trans. Roy. Soc., Vol. CLXVIII., 1879, p. 169, pl. ix., figs. 1, 1a; Tryon, Man. Conch., Vol. III., pp. 100, 197, pl. lxxvii., figs. 357, 358; Smith, 'Southern Cross' Mollusca (1902), p. 202; Martens, Deutsch. Tiefsee Exped., Vol. VII., p. 63 (1903).

Six miles N.W. of Hut Point, 180 fathoms.

A single specimen only was obtained. It is of the same elongate type as those collected by the 'Southern Cross' Expedition at Cape Adare in 7–10 fathoms.

* For explanation of plates, see Lamellibranchiata, p. 7.

### Neobuccinum tenerum.

(Pl. I., figs. 2, 2a.)

Shell small, ovately fusiform, thin, subpellucid, horn-colour, covered with a very thin periostracum, exhibiting somewhat remote, slender, threadlike, arcuate, longitudinal liræ, and rather obscure spiral striæ between them. Whorls $6\frac{1}{2}$ convex, the first $2\frac{1}{2}$, forming the large protoconch, smooth, glossy; the rest not shining, separated only by a slightly oblique suture, the last rounded above, contracted anteriorly; aperture subpyriform, acuminate above, and produced anteriorly into a short, open channel; labrum just a trifle thickened, brownish white within, gently curved in the middle when viewed laterally, very slightly faintly expanded, with a very shallow, broad, indistinct sinuation towards the suture; columella curved above, rather straight below the middle, covered with a thin glossy callosity. Length, 15 millim.; diam., 7; aperture, 6·5 long, 3·3 broad. Operculum (pl. I., fig. 2a) horny, reddish brown, marked externally with lines of growth, and exhibiting a nucleus which is paucispiral at the nuclear end. Lower surface roughened, with a narrow, red, raised ridge, parallel with the outer margin, which is smooth and shining. Length, 5 millim.; width, 3.

Off Coulman Island, 100 fathoms.

The general form of the shell and the character of the operculum agree with *Neobuccinum*. It is of thin and delicate texture, and the very fine periostracum is produced upon the threadlike riblets at the upper part of the whorls, forming a sort of fringe below the suture. The riblets are about twenty in number on a whorl. Only a single specimen was obtained.

### Troschelia ?

(Pl. I., fig. 8.)

Off Coulman Island, 100 fathoms.

A young specimen, 19 millim. in length, is of interest as indicating the presence in the Antarctic region of a large species allied to *Troschelia* or *Sipho*, indeed, it bears considerable resemblance to the upper part of the northern *Trosch. berniciensis* (King). It consists of about seven whorls, which are slightly convex, increase slowly, and, although rather water-worn, the five upper ones exhibit traces of spiral striation. The two last whorls are covered with numerous thread-like spiral liræ, some of which are thicker than others. These are crossed by oblique delicate lines of growth, and a thin straw-coloured periostracum invests the entire shell, excepting the upper worn volutions. Being a young shell, it is impossible to describe the probable form of the aperture or the character of the labrum and anterior canal of the adult. The last whorl is somewhat inflated at the middle, and contracted below into a short twisted recurved beak. The operculum is reddish, horny, and of the ordinary fusoid or unguiculate character, exhibiting distinct lines of growth and a terminal nucleus. A large operculum

(14·5 mm. in length), similar in character, was obtained off Hut Point, 11th November, 1902, which probably belonged to a more or less adult specimen of this species.

The genus *Boreofusus* of Sars is a synonym of *Troschelia*, and possibly *Buccinofusus* of Conrad, which has priority, may also be congeneric.

### Trophon longstaffi.

(Pl. I., figs. 3–3d.)

Shell ovately fusiform, white, rather thin, longitudinally delicately plicate; whorls 6–7, the two apical forming the protoconch (fig. 3b.) globose, smooth, glossy; the rest convex, rather shouldered above, separated by an oblique deep suture, ornamented with numerous thin lamellæ, which are directed forward, and often somewhat produced at the upper part, especially upon the body-whorl. They vary in number from 10 to 20 upon the last whorl, but generally average about 16. The surface is also sculptured with very fine spiral striæ both between the lamellæ and upon their upper surface, but their lower is smooth. The last whorl is contracted below and produced into a short oblique snout which is directed towards the left. The aperture is pear-shaped, with the canal considerably longer than the spire, smooth and white within. The outer lip in the most adult specimen is a little thickened within, sharp at the edge, and somewhat patulate and united above, with a distinctly defined callosity which covers the columella. The anterior canal is short and oblique.

Length, 41 millim.; greatest diameter, 25·5; aperture, with canal, 25 millim. long, 12 broad.

Flagon Point, 1 mile N. of ship, 20 fathoms; holes 4, 12, in 25–41 fathoms.

The animal externally appears to be normal, the tentacles are short, compressed, pointed at the tip, with the minute sessile eyes situated about midway upon the outer edge. The operculum (figs. 3c., 3d.) is elongate-ovate, rather thin, of a reddish horn colour, slightly convex externally, marked with distinct lines of growth from the apical nucleus, and also exhibiting a few arcuate rays, which curve from the apex to the inner margin. The lower concave surface is finely wrinkled, with a broad, glossy, reddish and somewhat thickened margination on the outer edge, and is dull upon the rest of the surface.

This species does not compare closely with any of the described forms. Perhaps the Patagonian *T. laciniatus* is its nearest relation. It is, however, rather different in form, its whorls are broader, and the lamellæ are not produced above into hollow spine-like projections. The aperture also is devoid of the orange or brown colour which distinguishes the South American shell.

### Trophon coulmanensis.

(Plate I., figs. 4–4b.)

Shell fusiform, turreted, white within and without, ornamented with somewhat distant thin lamellæ, about ten on a whorl, which are produced at the upper part or

shoulder of the whorls into erect hollow spines. Whorls 5, the two apical, forming the protoconch (fig. 4b), smooth, globose; the rest slopingly tabulated above, almost straight at the sides, but a little contracted below towards the suture, sculptured between the lamellæ with fine spiral striæ, which are crossed by very fine lines of growth, producing a textured appearance. The body-whorl is contracted below the middle and terminates in a slender oblique recurved snout. The aperture is elongate-pyriform, with the canal, exceeding half the entire length of the shell. Columella contorted, covered with a smooth, glossy, pellucid callus.

Length, 13 millim.; diam., 7; aperture and canal, 7 millim. long, 2·50 broad.

Off Coulman Island, 100 fathoms.

Only a single specimen of this species was obtained. In general form it is very like the var., *gunneri* of the northern *T. clathratus* (see Sars, Moll. Reg. Arct. Norvegiæ, pl. xv., figs. 11, 11a). It may be separated on account of its much larger protoconch, and more distinct sculpture between the lamellæ. The latter are rather more erect and spine-like at the upper part of the whorls, and the aperture is entirely devoid of colour.

### Thesbia? innocens.

(Pl. I. figs. 1–1b.)

Shell small, moderately elongated, turreted, dirty-whitish within and without, rather thin, not glossy, finely, yet distinctly, spirally striated; whorls 5, considerably convex, the first $1\frac{1}{2}$ forming the smooth glossy protoconch; suture oblique, deep; last whorl contracted anteriorly, more closely striated upon the cauda than above; aperture occupying about $\frac{3}{7}$ of the entire length of the shell; labrum thin, prominent and curved at the middle, broadly and shallowly sinuated above; columella slightly arcuate, covered with a thin callosity which is joined to the upper end of the labrum; anterior canal short, rather broad, oblique, scarcely recurved.

Length, 7·5 millim.; diam., 3·5; aperture, 3·25 millim. long, 1·5 broad.

Operculum (fig. 1b) minute, horny, thin, yellowish, roundly ovate, with a sub-terminal nucleus and exhibiting lines of growth, and also some radiating lines or striæ.

Hole 12. In 25–30 fathoms; also Hut Point, Feb. 13, 1904.

The genus, or sub-genus, *Thesbia* is said to have no operculum, but the present species has a very minute one which might easily be overlooked. It agrees, however, so closely in other characters with the type of the genus (*T. nana* Lovén*) that I do not feel inclined to separate it from this group only on that account.

### Admete delicatula.

(Pl. I., figs. 5, 5a.)

Shell fusiformly ovate, minutely rimate, very thin, dirty white, ornamented with numerous fine thread-like spiral liræ, and excessively delicate close-set lines of growth.

* Forbes and Hanley, Brit. Moll., vol. iv., pl. cxii., fig. 8; Jeffreys, Brit. Conch., vol. v., pl. lxxxviii., fig. 4; Sars, Moll. Reg. Arct. Norv., pl. xvi., f. 2.

Whorls $4\frac{1}{2}$, rapidly increasing, very convex, the last very large, rather ventricose; protoconch, consisting of $1\frac{1}{2}$ whorls, smooth, rounded, forming a rather large button-like apex; aperture semiovate, dirty whitish, delicately grooved within, the grooves corresponding with the external liræ, occupying not quite $\frac{2}{3}$ of the whole length of the shell; labrum thin, simple; columella slightly oblique, very little arcuate, with a thin reflexed callosity at the lower part which forms the slight rimation.

Length, 9 millim.; diam., 5·5; aperture, 5·5 long, 2·5 wide.

Winter Quarters, 130 fathoms.

Only two dead examples of this species were obtained. It is remarkable for its thin, delicate structure and the fine spiral liræ. These are not all of the same strength, but here and there occurs a more slender one than the rest. Upon the penultimate whorl there are about six or seven, five on the preceding volution, and about twenty on the last. There are traces of a thin periostracum which would be striated by the lines of growth. These are continuous both upon and between the liræ.

Temporarily placed in *Admete* until further information respecting it can be obtained.

### Amauropsis ? rossiana.

(Pl. I., figs. 6, 6a.)

Shell globose, imperforate, rather thin, clothed with a brownish olive periostracum, exhibiting fine oblique lines of growth, numerous rather obscure spiral striæ, and a few peculiar oblique malleations upon the last and penultimate whorls; spire somewhat raised, eroded at the apex; whorls 5 (?), 2–3 remaining ones very convex, separated by a rather deep suture; aperture obliquely semicircular, bluish white, occupying nearly $\frac{2}{3}$ of the entire length of the shell; collumella oblique, rather straight above, curving anteriorly into the lower margin, covered with a white defined callus which is thickened and reflexed over the umbilical region. Length, 29 millim.; greater diameter, 25; lesser diameter, 21; aperture, 18 millim. long, 11·5 wide. Operculum unknown.

Hut Point, Feb. 13, 1904.

Two dead shells only were obtained at this locality. They are remarkable on account of the peculiar oblique obscure ridges upon the last and penultimate whorls. These are most noticeable upon the penultimate volution just above the insertion of the outer margin of the aperture. Between the oblique ridges the surface is somewhat flattened and has a malleated appearance. The species seems to be separable from the several forms which occur at Kerguelen Island. Provisionally placed in *Amauropsis* until the animal and operculum are known.

### Natica (Neverita) delicatula.

*Natica delicatula*, Smith, "Southern Cross" Report (1902), p. 206, pl. xxiv., fig. 6.

Winter Quarters, 130 fathoms.

One small specimen only. It has the spire preserved, and consists of $3\frac{1}{2}$ well-

rounded whorls. I am inclined to think that this species, founded on a single shell, will eventually prove to be merely the young state of *N. grisea* Martens, found at Kerguelen Island.

### Neoconcha vestita.

(Pl. I., figs. 11–11c.)

Shell subglobose, rimate, very thin, semi-transparent, pale horn colour, covered with a periostracum which invests the entire surface, including the apex, and which, when moistened, is thick, but shrinks and seems thinnish when dry. It is produced at the upper part of the whorls, a little below the suture, into a series of short spines, forming a sort of coronation. Whorls three, very convex and rapidly increasing; the two apical (the periostracum being removed) are whitish, glossy, glassy, and finely spirally striated; the last is very large, globose, exhibiting oblique lines of growth of periostracum, which are produced over the deep canaliculate suture. Aperture broadly pyriform; peristome thin, simple, the columellar margin, however, being of a brown colour and somewhat reflexed.

Greater diameter, 7 millim.; height, 8; aperture, 5·25 millim. long, 4·5 wide.

The operculum (fig. 11b), is horny, reddish, somewhat triangular, with the outer margin curved, the converging sides straight, the nucleus terminal and marked with rather coarse, curved lines of growth.

Off Coulman Island, in 100 fathoms.

Only a single specimen was obtained. It has the appearance of being the young state of a shell that might grow to a considerable size, judging from the large apical whorls. When first received, before its removal from the spirit, the periostracum was thick and spongy, and enveloped the entire shell, and had the appearance of being keeled at the upper part of the body-whorl.

The foot of the animal has a double margin in front, the tentacles are rather short, subulate, with the eyes sessile at their outer bases, and the head is prolonged into a long, slender rostrum. Radula (fig. 11c) 2, 1, 1, 1, 2, tapering towards the anterior end. Central tooth with a median cusp, and two smaller ones on each side; laterals with three or four cusps, inner marginal tri- or quadri-cuspidate; outer marginal simple, hooked.

The Rev. H. M. Gwatkin, who very kindly extracted and mounted this radula for me, considers that it approaches that of *Crepidula* and *Calyptræa.* The character of the shell and the presence of an operculum at once separate it from those groups. It apparently represents a new generic type, for which I would suggest the name *Neoconcha.*

### Trichoconcha mirabilis.

(Pl. I., figs. 7–7b.)

Shell depressed, orbicular, umbilicated, thin, light, flexible, covered with a yellowish, very hairy periostracum, marked with strong oblique lines of growth, upon

which the hairs are arranged in spiral, longitudinal series. Spire not raised above the last whorl; whorls $4\frac{1}{2}$, very rapidly enlarging, separated by a deep, channelled suture; first $2\frac{1}{2}$, the protoconch, white, shelly, smooth, convex, not covered with periostracum; the last very large, inflated, slightly descending anteriorly; aperture, large, subcircular, brown within; peristome thin, continuous, the columellar margin slightly reflexed.

Greater diameter, 29 millim.; lesser diam., 20·5; height, 19 millim.; aperture, about 16 millim. in height and width.

Operculum (fig. 7c) small, horny, reddish, lamellar, marked with fine lines of growth, and having the nucleus lateral and marginal. Length, 7 millim.; width, 5·5.

Off Coulman Island, 100 fathoms, one adult specimen; off Mount Erebus, 500 fathoms, one young example.

The much-contracted animal is of an uniform light reddish colour in spirit. Edge of mantle fringed, finely subpapillate, the papillæ being grooved above. Head produced into a long, non-retractile, pointed, annulated rostrum, which appears to be divided above down the middle by a groove, which starts at the front part of the head between the tentacles. The latter short, conical, pointed, laterally compressed, with the sessile eyes at their outer base. Foot moderate, with a double margin in front, and with a distinct groove above the side and hind margins. Penis moderate, behind the right tentacle.

Radula (fig. 7b), 2, 1, 1, 1, 2, of a brown colour; central tooth quadrate, acutely unicuspid, laterals wider, subquadrate, with a single long, smooth cusp; marginals simple, hooked or curved.

This, perhaps, is the most interesting Gastropod found by the Expedition. It at once stands out as distinct from anything hitherto obtained from the Antarctic region. The shell, which is quite flexible and tough, like a chestnut skin, and the beautiful hairy periostracum are the two main characters of this very remarkable species.

The shelly protoconch, which is succeeded by the soft, flexible lower whorls, is most unusual, and the reverse is much more common. For example, the protoconchs in "The Tritons," Doliums, Purpuras, and other groups are more or less horny, the adult shells being solid and calcareous. Generically, it is allied to *Trichotropis* and *Velutina*, but the character of the radula is somewhat different, and there are differences both in the shell and operculum which are sufficient to separate it.

### Eulima convexa.

(Pl. I., figs. 9, 9a.)

Shell small, elongate, pellucid white, exhibiting the red dried remains of the animal, smooth, glossy, rather blunt at the apex; whorls 8, a little convex, slowly and regularly increasing, narrowly marginate beneath the slightly oblique suture; aperture ovate, acuminate above; peristome whitish, the outer margin curved forward

in the middle, somewhat sinuated above and at the base; columellar margin thickened, reflexed, joined above to the outer lip by a thin callosity.

Length, 5·75 millim.; diam. 2; aperture, 1·5 long, 1 broad.

Holes 9, 12. In 25–51 fathoms.

The whorls are more convex than in many of the known small species. *E. amblia*, Watson, from between Marion and Prince Edward Islands, has longer and flatter whorls, a longer aperture, and is smaller.

### Scala antarctica.

(Pl. I., figs. 10–10b.)

Shell small, elongate, imperforate, dirty whitish, greyish towards the upper part of the spire; whorls 7–8, very convex, divided by a somewhat oblique suture, exhibiting fine lines of growth and thickened varices, one or two upon each whorl; last whorl obtusely keeled around the base; apex blunt, globose; aperture roundly ovate; peristome thickened and a little expanded.

Length, 10 millim.; diam., 3·5; aperture, 2·5 long.

Hole 12. In 25–30 fathoms.

Remarkable on account of the smooth, rounded whorls, and thickened varices. When closely examined, the dirty whitish colour is seen to be composed of numerous irregularly interrupted spiral and longitudinal lines, producing a minutely cancellated appearance (see fig. 10b). Operculum normal (fig. 10a), yellowish, horny, redder in the centre.

### Rissoia adarensis.

(Pl. II., fig. 2.)

*Rissoa adarensis*, Smith, 'Southern Cross' (1902), p. 205, pl. xxiv., fig. 17.

Shell elongate ovate, white, smooth, glossy, imperforate; whorls 5, considerably convex, marked with fine striæ of growth; apex large, globose, smooth; suture a little oblique; aperture ovate; peristome continuous, outer margin a little thickened externally, columellar margin narrowly reflexed.

Length, 3·3 millim., diam., 1·5; aperture, 1 long.

Operculum thin, minute, ovate, paucispiral, a little concave above, without any process on the under side.

Holes 4, 12. In 25–41 fathoms.

A pure white semi-transparent species, without any striking characters. Allied to *R. georgiana*, Pfeffer, from South Georgia, but different in form. The finer series of specimens obtained by the 'Discovery' shows that this species is sometimes a little longer than the type originally described, and may consist of five whorls. The trace of faint longitudinal costation referred to in my former description is produced by some of the lines of growth being more pronounced than others. *Rissoa* (*Setia*) *columna*, Pelseneer, is very similar.

### Rissoia fraudulenta.

(Pl. II., fig. 3.)

Shell small, ovate-elongate, scarcely rimate, thin, semi-transparent, dull, dirty whitish; whorls 5, convex, divided by a slightly oblique suture, ornamented with fine spiral striæ, crossed by the still more delicate lines of growth; protoconch large, smooth, globose; aperture ovate, occupying rather more than a third of the entire length; outer lip thin; columella margin very slightly reflexed, united above to the labrum by a thin callus.

Length, 2·5 millim.; diam., 1·5; aperture, 1 in length.

Hole 3. 12¾ fathoms. Stones and gravel.

The principal features of this shell are the spiral striæ, convex whorls, and dull surface.

### Rissoia gelida.

(Pl. II., fig. 5.)

Shell ovate, acuminate above, imperforate, dirty whitish, ornamented with fine spiral liræ; spire obtusely conical; whorls 5, very convex; apex smooth; suture deep, a little oblique; aperture broadly ovate, rather large, occupying about five-twelfths of the entire length of the shell; labrum thin, a little effuse, especially at the base; columella narrowly reflexed, united above to the labrum by a thin callosity.

Length, 3 millim.; diam., 1·75; aperture, 1·25 long.

Operculum normal, paucispiral, thin, without any process.

Holes 3, 4, 12. In 12¾–41 fathoms.

The spiral threads are five or six in number on the penultimate whorl, and about twelve on the last.

### Rissoia deserta.

(Pl. II., fig. 1.)

Shell ovately conical, imperforate or scarcely rimate, dirty whitish, semi-transparent, dull, sculptured only with fine striæ of growth; whorls 5, convex, narrowly margined beneath the suture; spire conical, blunt at the tip; suture very slightly oblique; aperture almost circular; peristome thin, continuous, outer margin simple, columellar edge narrowly reflexed.

Length, 2·5 millim.; diam., 1·75; aperture, 1 long.

Winter Quarters, Feb. 20, 1902, and March 19, 1902, 10 fathoms.

In form rather like *R. gelida*, but at once separable on account of its smooth surface.

### Rissoia glacialis.

(Pl. II., fig. 4.)

Shell ovately conical, narrowly perforated, white, smooth, glossy, exhibiting only fine striæ of growth; whorls 5–6, very convex, and consequently separated by a deep

suture, which is only slightly oblique; aperture rounded, a little longer than broad; peristome continuous, the outer or right margin being simple and unthickened, and the columellar edge is slightly reflexed.

Length, 3·5 millim.; diam., 2; aperture, 1·2 long.

Holes 10, 12. In 25 and 127 fathoms.

A smooth shell without any striking features. Two specimens only were obtained. They differ from the other smooth species here described, *R. adarensis* and *R. deserta*, in form. The body-whorl is broader than that of the former, so that the spire looks more conical, and the spire is more produced than that of the latter, the mouth of which is larger and rounder than in the present species.

### Lovenella antarctica.

(Pl. II., figs. 6, 6a.)

Shell elongate, subulate, white, not very sharp at the apex; whorls 9, rather convex, gradually enlarging, separated by a slightly oblique suture, the three apical very finely and closely longitudinally costate, the rest transversely ridged, and marked with fine lines of growth; ridges or liræ, generally four in number on the upper volutions, and about eight on the last whorl, which is contracted anteriorly into a short rostrum; aperture subovate, produced in front into a short, slightly oblique, open canal; outer lip or labrum thin, simple; columella arcuate in the middle, obliquely truncate beneath.

Length, 7·25 millim.; diam., 2·5; aperture, 1·75 long.

Operculum (fig. 6a) thin, brown, ovate, paucispiral, consisting of about three whorls, the nucleus being lateral, but somewhat within the margin.

Hole 4. In 41 fathoms.

This very interesting species is at once recognisable on account of the difference of sculpture of the upper and lower whorls. The minute apex is smooth and involuted. The first of the costate whorls has about eighteen to twenty-five riblets, which increase somewhat in number on the next whorl, being closer together. There does not appear to be any transverse sculpture on these whorls. The lines of growth on the lower volutions are rather distinct, especially between the spiral liræ. The base of the body-whorl, around the columella, is rather smooth. The type of the genus, *Lovenella metula* (Lovén), has the second whorl finely and closely costellate, in a manner very similar to that which obtains in the present species.

### Valvatella dulcis.

(Pl. II., fig. 8.)

Shell turbinate, narrowly but deeply umbilicated, iridescent blue, more or less obscured by whitish, close-set, oblique, thread-like lines of growth and less pearly spiral liræ; whorls 5–5½, convex, the first 2½ yellowish, the penultimate with three or four

spiral liræ, the last with about eighteen, not counting some very fine ones within the umbilicus; four round the middle of the whorl stronger than the rest; apex smooth, obtuse; lines of growth more conspicuous between than upon the ridges, aperture irregularly rounded; peristome thin, outer margin grooved within, the grooves corresponding to the external ridges; columella a little arcuate, scarcely reflexed.

Greater diam., 9 millim.; height, 7; aperture, 4 wide.

Operculum yellowish, a little concave externally, consisting of about nine whorls.

Winter Quarters, June 18, 1903. In 130 fathoms.

The distinct lines of growth cross the spiral ridges, but are less conspicuous upon than between them. The aperture is more beautifully iridescent blue than the exterior. With regard to the use of the generic name *Valvatella* in preference to that of *Margarita*, see the writer's remarks in the Proc. Malac. Soc., Vol. III. (1898), p. 205.

### Valvatella crebrilirulata.

(Pl. II., fig. 9.)

Shell turbinate, very narrowly perforate, white, sculptured throughout with very fine numerous thread-like spiral lines, and fine oblique striæ of growth; spire elevated, conical, bluntish at the tip; whorls 5, the apical one smooth, glossy, suborbicular, the rest convex, but indistinctly angled at the middle, the angle in the body-whorl being above the periphery; aperture rather large, nearly circular; peristome continuous, outer margin thin, columellar edge a little thickened and reflexed.

Height, 6·5 millim.; greater diam., 6; aperture, 3·25 broad.

Hut Point, Feb. 13, 1904.

The spiral threads vary a little in slenderness. There are ten to twelve on the penultimate whorl, and twenty-five to thirty on the last. The umbilicus is a narrow perforation, partly covered by the reflexed columellar margin of the peristome.

### Valvatella refulgens.

(Pl. II., fig. 7.)

Shell small, turbinate, very narrowly umbilicated, pearly iridescent, more or less covered with a whitish shelly film, smooth, with the exception of delicate oblique lines of growth; whorls 4, very convex, the last obliquely slightly descending; aperture moderately large, circular, beautifully bluish pearly within; peristome thin, the margins joined by a thin callus, columellar edge expanded and slightly reflexed.

Greatest diam., 5 millim.; height, 5.

Operculum very thin, yellowish horny, concave externally, many-whorled.

Winter Quarters, 10–130 fathoms.

A very beautiful little species, sometimes quite pearly externally as well as within. It is simple in design and ornamentation, exhibiting merely fine incremental striæ. It recalls the *V. helicina*, Fabricius, of northern seas, but it has a higher spire and a smaller body-whorl.

### Valvatella minutissima.

(Pl. II., fig. 10.)

Shell very small, turbinate, very narrowly perforate, pellucid white, delicately spirally striated; whorls 4, very convex; aperture rounded; peristome thin, with the columellar margin a little thickened and expanded.

Length, 2·5 millim.; greatest diam., 2.

Winter Quarters, Feb. 20, 1902.

Only a single specimen, which, although so small, appears to be adult. The surface is a little worn, but the spiral striæ are quite evident in places. It differs from *V. refulgens* in its more elevated spire, smaller size, and sculpture.

### Lepeta (pilidium) antarctica.

(Pl. II., figs. 11, 11a.)

Shell small, cap-shaped, thin, dirty-whitish, narrowly ovate at the circumference, moderately elevated, with the apex curved over anteriorly, so that it is almost in a position perpendicular to the margin. The sculpture consists of fine radiating liræ which are minutely scaled by the lines of growth, and those down the posterior part of the shell are rather more conspicuous and stronger than those upon the anterior surface. Interior smooth, white, slightly iridescent.

Length, 4 millim.; diam., 2·75; height, 2.

No. 10 hole, 130 fathoms.

Only a single specimen obtained. Narrower than the *L. coppingeri*, Smith, from the Straits of Magellan, with fewer radiating liræ.

### Bullinella gelida.

(Pl. II., fig. 12.)

Shell cylindrical, a little broader below than above, very thin, white, sculptured with slightly oblique curved lines of growth; apical perforation small, funnel-shaped, roundly keeled at the circumference; aperture narrow above, widening anteriorly; outer lip on a level above with the end of the whorl, deeply sinuated; columella thickened, reflexed, oppressed.

Length, 13 millim.; diam., 7.

Winter Quarters, 130 fathoms.

Without any striking features, but apparently separable from allied forms. It is represented in Arctic seas by *B. nucleola*, Reeve, which seems to me distinct from *B. alba*, Brown, with which it has been united by Pilsbry (Man. Conch., vol. xv., p. 291).

# MOLLUSCA.

## III.—AMPHINEURA.

By Edgar A. Smith, I.S.O.

### Chætopleura miranda.*

(Pl. II., figs. 13–13g.)

Animal elongate, more than twice as long as broad; valves thin, acutely keeled along the middle, flatly sloping on each side, standing erect posteriorly, one above the other; anterior valve (fig. 13b) with eight to ten slender radiating costæ, slender above, and gradually thickening towards their extremity, radiately striate or sulcate between the ribs; medium valves (fig. 13c) with a single costa on each side, the rest of their surface being radiately sulcate or striated and marked with fine lines of growth; the posterior valve (fig. 13d) has the mucro behind the centre, and, besides the radiating sulcation, exhibits one or two more conspicuous sulci diverging laterally from the apex; the girdle is clay-coloured, rather broad, fleshy, closely beset with short spicules; colour of valves dirty whitish, excepting the third and seventh, which are more or less reddish; insertion plates thin, that of front valve with nine fine, short slits corresponding to the external ribs (fig. 13e); intermediate valves (fig. 13f) with a single lateral slit, posterior valve (fig. 13g) with six slits.

Length (including girdle), 55 millim.; diam., 25; height from sole of foot to the apex of the fourth valve, 12 millim.

Winter Quarters, Holes 6, 10. In 125–130 fathoms.

Three specimens of this interesting chiton were obtained, all agreeing in colouration, which is remarkable, as only the third and seventh valves are stained with red, the rest being dirty whitish. The gills extend about two-thirds along the side of the foot.

* Mr. Smith has this morning received Dr. J. Thiele's report on the Chitons of the "deutscher Tiefsee Expedition," in which (vol. ix., p. 332) this species is noted as *Notochiton* [g.n.] *mirandus;* the locality cited (Bouvet Island) shows the wide distribution of the species.—Ed., Oct. 22, 1906.


1
1a
1b
2
2a
3
3a
3b
3c
3d
4
4a
4b
5
5a
6
6a
7
7a
7b
7c
8
9
9a
10
10a
10b
11
11a
11b
11c


Antarctic (Discovery) Exp. Shells pl. 2. E. Wilson, Cambridge.

# MOLLUSCA.

## IV.—NUDIBRANCHIATA.

(1 Plate.)

By Sir Charles Eliot, K.C.M.G., LL.D., *Vice-Chancellor of the University, Sheffield.*

The Nudibranchiata collected by the 'Discovery' consist of the following species:—

*1. Tritonia challengeriana Bergh.
*2. Tritoniella belli. Gen. et spec. nov.
3. T. sinuata. Spec. nov.
4. Bathydoris hodgsoni. Spec. nov.
5. B. inflata. Spec. nov.
6. Doto antarctica. Spec. nov.
*7. Notaeolidia depressa. Spec. nov.
8. Cuthonella antarctica. Spec. nov.
9. C. paradoxa. Spec. nov.
10. C. modesta. Spec. nov.
11. ? Cratena sp.
12. Galvinella antarctica. Gen. et spec. nov.

All the above forms are represented by a single specimen except *Tritoniella belli*, of which there are five. Three minute Aeolids stated to have been with No. 11 have been lost. The bottle was broken, and only the remains of one specimen were found.

Many of the specimens appear to be well preserved, but, in addition to the changes in colour and shape which usually affect Nudibranchs kept in alcohol, they have undergone exceptional vicissitudes, such as being frozen into solid lumps when first taken out of the sea. It is therefore not surprising if the external appearance has been altered in some cases. A superficial examination of the specimens of *Tritoniella belli* suggests that they comprise three species of very different shape, but as the anatomy is identical and the naturalists who saw the living animals regarded them as all of one species there cannot be much doubt that the differences are due to distortion. The real appearance of such forms as *Bathydoris hodgsoni* must remain a matter of doubt, and the species can be safely defined only by anatomical characteristics.

I have some doubt as to the reality of the distinction between *Tritoniella belli* and *T. sinuata*, and between *Bathydoris hodgsoni* and *B. inflata*. The differences, both external and internal, are sufficient to provide specific characters, but it is possible that these characters may really be due to the state of preservation and to age, the second

* Of these species only are there any specimens in the Museum available for investigation.—Ed.

species of each genus being much smaller than the first. The differences in the radulæ may be due to growth, for in both genera the teeth near the rhachis are very irregular and undefined in outline.

With the exception of *Tritonia challengeriana,* already recorded from the west coast of Patagonia, all the forms appear to be new. Some uncertainty must exist about *Doto antarctica,* which greatly resembles *Doto fragilis,* but there are some points of difference and it seems safer to create a new species, for it is a considerable assumption to take for granted that similar forms from northern and southern seas are specifically identical.

The Nudibranchiata of the Arctic and Antarctic oceans with their neighbouring waters show considerable general resemblances, as far as the faunas are known. There is a marked scarcity of Dorids and a preponderance of Tritonids and Aeolids. It must be remembered, however, that Dorids are most abundant under large stones in the littoral zone, and that even if they exist in such localities on ice-bound shores, they are not likely to be brought up by the dredge. But it would seem that even in accessible waters they decrease in numbers towards the extreme south. A collection of Nudibranchs made in the Falkland Islands contains only five Dorids referable to two species, but nearly forty Aeolids, referable to about four species, and seven Tritonids. The 'Belgica' obtained only *Tergipes antarcticus.* The present collection and that made by the Scottish National Antarctic Expedition have together yielded eleven specimens of Tritonids, eight of *Notaeolidia,* one of *Doto,* eight of various Aeolids, two of *Bathydoris,* and no ordinary Dorids at all. *Acanthodoris,* however (which with the allied *Adalaria* has been found far north in both the Pacific and Atlantic), is recorded from New Zealand and Cape Horn (Rochebrune and Mabille), and probably extends further south. *Archidoris* is recorded from Kerguelen Island, Cape Adare and Wandel Island.*

The two collections are too small to warrant any conclusions as to the absence of forms which are not represented, but, as far as they go, they indicate that the Arctic and Antarctic Nudibranchs are similar rather than identical. As for species, Dr. Bergh regards an *Acanthodoris* found in New Zealand as a variety of *A. pilosa,* and the animal here described as *Doto antarctica* may possibly be a variety of *D. fragilis.* The genera *Tritonia* and *Bathydoris* are common to both seas, and are also recorded from intermediate points, *Bathydoris* only from great depths. *Tritoniella, Tritoniopsis,* and *Notaeolidia* are recorded only from the south, while *Dendronotus* and *Campaspe,* though frequent in both the North Atlantic and North Pacific, and extending into the Polar regions, are not recorded from further south than the Bay of Biscay and California. The Antarctic Aeolids hitherto collected are allied to *Cratena* or *Galvina,* no *Facelinidæ* or *Coryphellidæ* having been found. It is remarkable that in all of them the vent is dorsal, not lateral.

* M. Vayssière (Bull. du Mus. d'Hist. Nat., (1906), 3. p. 147) gives preliminary diagnoses of the four Nudibranchs found by the 'Charcot' Antarctic Expedition (64° to 65° lat. S. and 64° long. W.). They are *Archidoris tuberculata*; *Guy-Valvoria* [*sic.*—Ed.], a new genus of the Aeolididæ; *Charcotia,* which apparently unites some of the characters of the Tritoniidæ and Tethymelibidæ; and *Notaeolidia gigas.*

*Galvinella antarctica* has eyes of normal size, and *Notaeolidia depressa* (like *N. gigas*) very minute ones. In the other specimens no eyes could be found, and though their absence cannot be regarded as certain, it is probable that the larger animals, at any rate, have none. As preserved, the specimens are mostly yellow, but it would appear that when alive they were milk-white or colourless. The Nudibranchs of the Scottish National Antarctic Expedition seem to have been white or pinkish.

## TRITONIIDAE.

THIS family consists of large slug-like animals of a somewhat rectangular shape. They have an undivided liver, no blood gland, one spermatotheca, a frontal veil, strong jaws and a large radula with a central tooth. As a rule they have arborescent branchiae set on the dorsal margin, simple rhinophores surrounded by plumes and retractile into raised sheaths, the hermaphrodite gland spread over the liver, and numerous smooth hamate lateral teeth, of which the first is larger than the others.

Five genera seem referable to the family :—

1. *Tritonia* Cuvier has all the typical characters mentioned above, and simple projections on the frontal veil. *Candiella* Gray is a subgenus.

2. *Marionia* Vayssière differs from the other known genera in having the stomach armed with horny plates. Otherwise it resembles *Tritonia*, but the processes on the frontal veil are generally branched.

3. *Atthila* Bergh has papillæ on the back, perfoliated rhinophores, a smooth frontal veil, teeth partly denticulate, and a different arrangement of the hermaphrodite gland.

4. *Tritoniopsis* Eliot (Trans. Roy. Soc. Edin., 1905, vol. XLI., part III., p. 530) has ridges on the back and a divergent radula.

5. *Tritoniella* gen. nov. resembles Tritonia in most points, but differs from it and from all the known genera in having not arborescent branchiae but simple processes or crenulations of the mantle margin somewhat like those of Lomanotus. The back bears ridges.

*Heterodoris* Verrill, from New England, very possibly belongs to the same family, and I cannot help suspecting that it is allied to *Tritoniella*, but the description is defective in some important points, and it is impossible to say to what group of the Nudibranchiata the animal should be referred.

*Marionia* is common in the tropics, the furthest points from which it is recorded being the Mediterranean and Buenos Ayres, but the other genera seem to prefer the colder seas.

## TRITONIA (Cuv.).

TWENTY-SIX species of this genus are registered (see Eliot, Jour. Mar. Biol. Assoc., VII. (1906), p. 335), but some of them should probably be referred to *Marionia*, as the difference between the genera is anatomical and the descriptions often imperfect.

The majority of the forms certainly referable to *Tritonia* are inhabitants of the cold or temperate seas, but the 'Siboga' expedition found two species in the Malay Archipelago. From the southern seas are recorded besides the present species *T. pallida* Stimpson (Cape of Good Hope), *T. incerta* Bergh (New Zealand), *T. appendiculata* Eliot (South Orkneys), *T.* (*Candiella*) *australis* (South Chile). The animal described as *Microlophus poirieri*, by MM. A. T. Rochebrune and J. Mabille in the "Mission Scientifique du Cape Horn," 1882–3, Vol. VI., p. 11–12 and plate 6, 1a and 1b., is probably a *Tritonia.*

### 1. Tritonia challengeriana (juv. ?).

Bergh, Chall. Rep. Nudibr. (1884), p. 45.

One specimen labelled "19, iii. 02, W.Q. (50), 10 Fath." It is well preserved and of a uniform pale yellow colour, probably due to the preserving fluid.

The animal is 29 mm. long, 9 broad, 7·5 high; not much tapering until quite the end of the body. The back is flat, not arched, almost smooth except for a few scattered minute tubercles. The foot is 5 mm. broad, rounded in front, and not grooved. Posteriorly, it is expanded into a sort of disc, but this may be a distortion.

The margins of the back and the foot are marked by very distinct lines, a little lighter in colour than the rest of the body, but not projecting much. There are eleven branchiæ on each side, and an additional tubercular prominence on the left. On the right side the largest are the fourth, sixth and seventh; on the left the fourth, fifth and seventh. These plumes are about 3 mm. long and 2 mm. wide at the top. They are not foliaceous or much developed, and consist of a rather long stout stem, generally indistinctly quadrifid, and bearing in all twelve to sixteen points. The smaller branchiæ are simpler and the smallest rudimentary. The genital orifices lie below and between the third and fourth plumes on the right; the vent (which is not much higher up) below and between the fourth and fifth.

The frontal veil is 8 mm. wide, thick, and not very ample. It bears sixteen small rounded tubercles, which give it an indented appearance. It is not distinctly bilobed, but there is a space in the middle where the tubercles are absent or obscure, so that it falls into two halves. No trace of a tentacular groove could be seen. Above the frontal veil the head forms a raised transverse ridge, terminating in the rhinophore openings, which point right and left and not vertically. The rims hardly project at all, but on the lower side a small process extends downwards. The club of the rhinophores is short and conical; it is surrounded by about ten simply pinnate plumes. The tips are protruded, and there are slight indications of a tentacle-like appendage on the upper ends.

The general colour of the intestines is yellowish. The central nervous system is as usual: the pleurocerebral ganglia pear-shaped, with signs of a division into two parts; the pedal round. No eyes were found. The jaws are yellow, narrow, elongated and convex. They are 7 mm. long, not counting the curve, and, as they lie folded, the

two measure 4 mm. across. The masticatory process is not long; both it and the edges of the jaws bear about five rows of denticles, the outermost very distinct. The radula is mahogany brown, and has a formula of at most 32 × 30.1.1.1.30. The median tooth is broad and tricuspid; the central cusp strong and triangular at the top, the side cusps rounder and more irregular. The first lateral is of the usual clumsy shape; the remaining laterals rather erect and bent at the tip. The salivary glands are about 5 mm. long; they look like smooth bands and are inconspicuously folliculate. The oesophagus proper is very short, and almost immediately after issuing from the buccal mass begins to dilate into a pouch which becomes the stomach, though it is hard to say at what points distinct names should be applied to the various portions of the digestive tract. The upper part of the stomach is laminated. The lower and larger part is enclosed by the liver, a not very compact mass, which bears on both the upper and lower side, but only here and there, yellow follicles of the hermaphrodite gland. The large and strong intestine issues from about the middle of the hepatic mass, runs forwards, and then turns to the right. Internally it is strongly laminated. The anterior genital mass is small (3·5 × 2·5), and the mucous and albumen glands not much developed. The vas deferens is moderately long and not much convoluted; the verge straight and conical; the spermatotheca round and not large.

This form is probably an immature specimen of *T. challengeriana* Bergh, recorded from the west coast of Patagonia. Differences are not wanting, particularly in the number of the branchiæ, which are only 11 here, whereas *T. challengeriana* has 25–30, but I do not think there is sufficient ground for creating a new species, and the animal cannot be certainly identified with *T. appendiculata*, to which it shows resemblances. The peculiar shape of the head and position of the rhinophore sheaths is perhaps not natural.

## TRITONIELLA.

Most of the characters are as in *Tritonia*, but the dorsal margin is wide and bears not foliaceous tufts, but simple unbranched prominences, which have a few lamellæ on the under side. Some of the specimens are exceptionally well preserved, and it seems clear that no appendages have been lost. The back bears a median longitudinal ridge and some irregular accessory ridges and tubercles. On the frontal veil are only slight prominences and indentations. The jaws are not denticulate; the radula is fairly wide with a median tooth. The stomach bears plate-like ridges, which, however, are not detachable.

The collection contains two species, which are best distinguished by the dentition. In *Tritoniella belli* (named in honour of Professor F. Jeffrey Bell, of the British Museum) the rhachidian tooth is broad, with a large cusp and rudimentary denticulation, and the first lateral is as in *Tritonia*. In *Tritoniella sinuata* the first lateral does not differ much from the others, and the rhachidian tooth is an inconspicuous flat plate.

*T. belli* appears to have two renal orifices situated close together. The second is possibly analogous to the pore of unknown functions in *Hexabranchus* (v. Bergh in Semper's Reisen, XVIII., p. 551, under *H. faustus*). In *T. sinuata* the orifices were contracted and their character could not be precisely determined.

### 2.—Tritoniella belli (Figs. A * and B).

The collection contains five specimens of this form, which present considerable differences in shape and in the greater or less development of the mantle margin and the processes which it bears. Mr. Hodgson, however, informs me that they all appeared to him to be the same species when captured, and were all milk-white. This and the identity of the internal anatomy cause me to describe them as one species and not to distinguish even varieties, since the diversity of appearance, though considerable, is probably due to artificial causes. The animals have no doubt the power of altering their shape from flat and broad to high and narrow, and the Tritoniidæ are very apt to have their mantle margin and branchiæ rubbed off, without any clear sign of the loss remaining. Besides being exposed to ordinary distortion, the present specimens were captured in a temperature which caused them to freeze into solid lumps before they could be placed in the preserving fluid.

The specimens may be classified as follows :—

A. One specimen captured at Hut Point, Winter Quarters, February 13, 1904, with the D net. It appears to be very well preserved, and is of a uniform pale yellow. Length 50mm., maximum breadth 30, height 19. The broad undulated mantle-edge bears a row of papillæ, and the oral veil is distinctly tuberculate.

B. Two specimens from McMurdo Bay, 4–10 fathoms, February 13, 1902, and one specimen captured with the D net at Winter Quarters, hole No. 12, on August 24, 1903. In all these specimens the edges of the mantle and of the oral veil are much less distinct than in A, and there are only a few processes. The measurements are as follows in millimetres.

| Length. | Breadth. | Height. | Breadth of foot. |
|---|---|---|---|
| 63 | 22·5 | 13·5 | 13 |
| 60 | 16 | 14·5 | 11 |
| 44 | 19·5 | 19 | 9 |

One of these specimens is represented in Figs. 1 and 2.

C.—One specimen captured with the D net at Hut Point, Winter Quarters, November 19, 1902. Colour, grey; back much arched; anterior portion, especially left rhinophore, greatly swollen. This specimen, which is superficially unlike all the others, appears to have suffered considerable distortion, which is confirmed by the fact that the viscera have been drawn up into the anterior part of the body cavity, leaving the posterior half empty.

* The letters refer to figures on the plate; the text figures are distinguished by cyphers.

When not otherwise stated, the following data and measurements apply to specimen A (Fig. 1).

Though it is rather hard to say where the dorsal margin begins, it is clearly 12 mm. wide in some places, and is wavy, with two sharp, but perhaps not natural, undulations inwards. Each side bears more than twenty points or papillæ, the largest 3 mm. high. They show no sign of branching or division, but the larger bear on the under surface a few folds. The oral veil is distinctly bilobed. Besides two projecting grooved tentacles of the type usual in *Tritonia*, it bears on the right lobe, which is larger, seven tubercles, and on the left lobe three, one of which is larger than the rest, and formed of three small tubercles fused together.

FIG. 1.—*Tritoniella belli*—SPECIMEN A FROM ABOVE.

The rhinophore sheaths are 5 mm. high and 4 mm. broad. The opening is not crenulate, and points somewhat outwards. The dorsal margin starts from the side of the sheath, which is somewhat elongated in this direction. The rhinophores themselves are conical knobs, surrounded by 6–8 much-divided plumes. There are a good many scattered knobs on the dorsal surface, especially about the point where the margin begins, though not on the edge of the flap. Down the middle of the back runs a longitudinal ridge. It bifurcates just before the rhinophores, and sends off a branch to each sheath. On the right, about the middle of the back, it gives off a T-shaped process. Between and in front of the rhinophores are four irregularly shaped tubercles. A little behind the rhinophores two ridges run inwards from the dorsal margin, but do not reach the median longitudinal ridge. The foot is rounded in front, and very slightly grooved. The margins are not expanded in any part, and

there is no tail whatever apart from the body. The genital orifices are 19 mm. and the anus 31 mm. from the anterior end; both lie just under the mantle margin. About 5 mm. in front of the anus lie two openings, close together, but quite distinct and probably renal.

The other specimens seemed to present the same configuration in a more or less damaged condition. Though they are larger, the dorsal margin is never more than 5–8 mm. in breadth, and often quite narrow. Only a few processes (3–7) remain on each side. Some of them are rather larger than in A, and though they show no traces of having been arborescent, or even simply pinnate, they bear one or two deep indentations. The tubercles on the edge of the oral veil are very indistinct. The ridges and tubercles on the back differ considerably in the different specimens, and seem to indicate a real variability. Traces of the T-shaped lateral ridge on the right are generally but not always present, and between the rhinophores there are from one to three tubercles of very varying shape and size (Figs. 2–4). The rhinophore

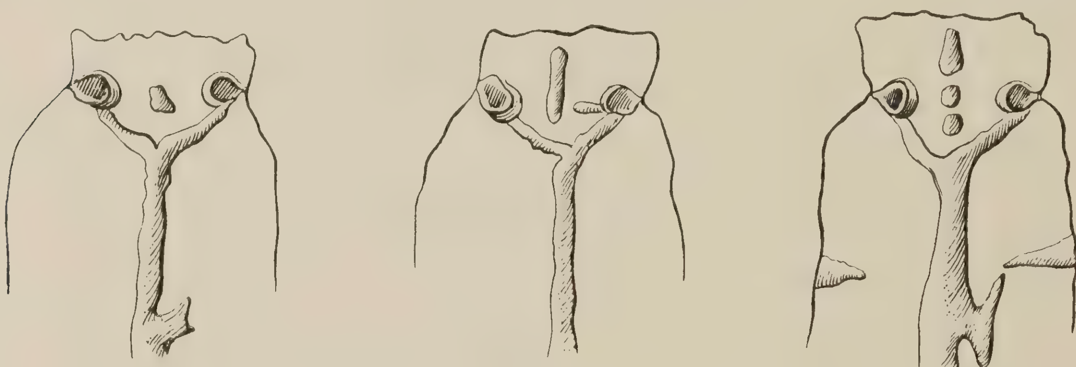


FIG. 2. FIG. 3. FIG. 4.

*Tritoniella belli*—ANTERIOR PART OF BACK IN THREE SPECIMENS SHOWING THE VARYING ARRANGEMENT OF TUBERCLES.

sheaths are directed either laterally or vertically, and their margins are generally turned outwards.

The body-walls are thick, the dorsal integuments much thicker posteriorly than in the centre of the back. The body cavity is only about 30 mm. long, the solid tail measuring 18·5 mm. The pericardium is not visible externally, and lies somewhat to the right of the median dorsal line. The central nervous system is as in *Tritonia*, but no eyes were discovered. The ganglia are very distinctly granulate and yellowish. The pedal ganglia are round, the cerebro-pleural larger, but without any sign of a division into two parts. The elongate, elliptical buccal ganglia are applied closely to the under side of the œsophagus at some distance from one another, and the small round gastro-œsophageal ganglia are united to them by long connectives.

The buccal mass is of the *Tritonia* type, and presents no important differences in any of the specimens. The jaws are strong (Fig. 5), very convex, and present a roughly circular appearance (with a diameter of about 7·5 mm.) as they lie together.

They are yellowish brown, and the edges are not black or denticulate. The masticatory process is very short and, as in many other forms, presents under a high power the appearance of a tessellated pavement.

The radula is of a mahogany brown, strong, and not at all fragile. It consists of from 50–58 rows, each consisting of a broad rhachidian tooth (Fig. 6), a large first lateral somewhat different from the rest (Fig. 7), and 60–70 hamate teeth (Fig. 8). The

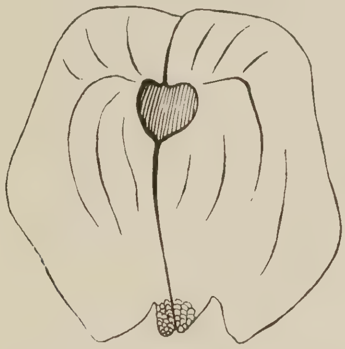


FIG. 5.—*Tritoniella belli*—JAWS.

rhachidian tooth has a strong, pointed, elevated, triangular central cusp, and about four rather irregular, not very pointed, denticles on each side. It seems to be a transition between the form of tooth found in *Tritonia* (see particularly *Marionia arborescens* in Dr. Bergh's Fig. 34, pl. lxxxviii., Malac. Unters, part XVII., in Semper's Reisen) and that found in *Bornella*, *Pleurophyllidia*, and *Notaeolidia*. The laterals are rather thick and clumsy, not much hooked, with small bases, and no kink in the back. The second

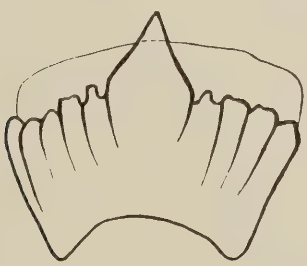


FIG. 6.—*Tritoniella belli*—RHACHIDIAN TOOTH.

FIG. 7.—*Tritoniella belli*—FIRST LATERAL TOOTH.

FIG. 8.—*Tritoniella belli*—THREE LATERALS FROM THE MIDDLE OF THE HALF ROW.

lateral from the rhachis is lower than the others, and has a broader base, and these features are much increased in the first, which, however, still preserves traces of the hamate shape.

The salivary glands consist of a thread-like duct and a long (as much as 24 mm. in one specimen) flocculent mass. The œsophagus is short, and soon enters the stomach, which has the appearance of a large tube, not much dilated, and never more

than 7 mm. wide. In the upper part are soft lamellæ and papillæ, and in the lower a ring of fifteen to twenty hard ridges, which look like the stomach plates of *Marionia*, but are not detachable. The circuit of plates is broken by the large liver duct which enters the stomach at about this point. The hinder part, but not the whole, of the stomach is enclosed in the greyish liver mass, which is itself covered here and there, but by no means everywhere, by a thick reddish layer consisting of the follicles of the hermaphrodite gland. The intestine is laminated internally. It issues from the middle of the liver mass, runs a long way forward, and then turns backward and to the right. In one specimen fragments of shells were found in the digestive organs.

The ampulla of the hermaphrodite gland is long (about 25 mm. × 4 mm., if straightened out), and folded about four times on itself. The vas deferens is reddish yellow, and lies in a few large, loose coils (about 40 mm. × 1·5 mm., if straightened out). The verge is rather small, conical, and pointed. The mucous and albumen glands are not large in any of the specimens, and it is probable that the animals were not captured in the breeding season. The spermatotheca has a short duct (2·5 mm.), and is elongate (about 8 mm. × 2 mm.), with strong, muscular walls. In all the specimens it is contracted and twisted in the middle. The external orifices of the reproductive organs are protected by folds of moderate size.

The renal orifice, which lies immediately in front of the vent, is remarkably distinct in all the specimens; and in most of them it can be seen that it consists of two openings, very close together, the anterior smaller than the posterior. Both appear to communicate with the renal apparatus, but the connection was not satisfactorily discovered. Attached to the intestine is the reddish, egg-shaped, renal vesicle, lined with branchia-like lamellæ.

### 3. Tritoniella sinuata (Fig. C).

One specimen, captured at Winter Quarters on October 8, 1903, with the D net in hole 12 (25–30 fathoms). It is of a uniform, light-yellow colour, and well preserved, but swollen ventrally, which is probably unnatural. It is narrower and higher than the specimen of *T. belli*, the measurements being: length, 30 mm.; breadth, 10·5; height, 12.

The dorsal margin rises vertically, not laterally, about 5 mm., and bears on each side 30 points, which are continued below into low ridges, running towards the centre of the back, but not reaching the central ridge. It is not clear if these transverse ridges are permanent, or mere folds produced by contraction. Three of the points are larger than the others, and measure 4 mm., including the ridges; five are of moderate size (3 mm., including the ridges), and the rest are small. On the under side of the points are a few indistinct lamellæ.

The oral veil is bi- or trilobed, as the central portion is somewhat expanded

in front. It bears two very distinct, grooved tentacles of the Tritonia type, and a number of faint indentations, apparently representing undeveloped tubercles in different stages of growth. Down the centre of the back runs a crinkled ridge, which is connected with the right but not with the left rhinophore—probably an abnormality in this specimen—and gives off a short asymmetrical side ridge on the right, about half-way down the back. Between the rhinophore pockets is a large, round tubercle. The back is covered everywhere with smaller tubercles, as are also the sheaths of the rhinophores, which are directed vertically. The genital orifices are about 9 mm., and the anus about 15 mm. from the head.

The central nervous system is as in *T. belli*, but the granulations of the ganglia are not very distinct. No eyes are visible.

The body walls are thick. The jaws are more elongate than in the other species and do not form a circle. They are not regularly denticulate, but the black edges bear numerous asymmetrical prominences. The radula is dark brown in front, yellow behind. The formula is 56 × about 70.1.70. Contrary to what is usual in Tritonids, the central tooth (Fig. 9) is hard to see, and is hidden by the laterals which bend over

FIG. 9.—*Tritoniella sinuata*—RHACHIDIAN TOOTH.

FIG. 10.—*Tritoniella sinuata*—THREE LATERAL TEETH.

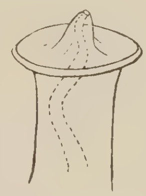


FIG. 11. *Tritoniella sinuata* —VERGE.

it. It is a flat plate with only faint indications of cusps. The laterals (Fig. 10) are thick, rather irregular in outline, and often with a kink in the back. The first lateral shows hardly any difference from the others.

The salivary glands are about 6mm. long and 2mm. broad. The stomach contains a girdle of 14 flat, broad ridges, plate-like, but soft and not detachable. They are about 4mm. long and 1·5 broad, and bear 7–10 irregular transverse striæ. They are not like those of the other species on account of their width and flatness. The stomach is full of black matter and the greater part of it is enclosed in the dark-grey liver, which is itself covered in many, but not all, parts by the reddish-yellow hermaphrodite gland. The intestine is laminated internally.

The reproductive organs resemble those of the other species, except that the verge (Fig. 11) has a broad flat top from which rises a conical point. The albumen and mucous glands are not much developed; the spermatotheca is elongate and tapering; the vas deferens extremely long and coiled.

The dentition seems to distinguish this species from *T. belli*, and there are also differences in the jaws, reproductive organs and stomach plates. Probably also the external appearance, particularly the mantle edge, is different.

## BATHYDORIS (Bergh).

(*Bergh*, Chall. Report Nudibr. (1884), p. 109 ; id., Ingolf Exp. Nudibr. (19—), p. 7.)

This remarkable genus is in many ways a link between the Tritoniidæ and Dorididæ. The shape is spherical, and the back bears deciduous papillæ. The head parts are much as in the Dorididæ ; the rhinophores perfoliate and non-retractile. The branchiæ consist of separate non-retractile tufts, set in a circle on the posterior part of the back. The powerful jaws and radula are much as in the Tritoniidæ. The hermaphrodite gland is separate from the liver. In the nervous system the cerebral and pleural ganglia are distinct and not fused.

Only four specimens of this genus are recorded, constituting as many species :—

1. *B. abyssorum* Bergh, obtained by the ' Challenger ' near New South Wales, in a depth of 2,425 fathoms.
2. *B. ingolfiana* Bergh, from Davis Strait, in 1870 fathoms.
3. *B. hodgsoni* spec. nov., from the Antarctic, in 100 fathoms.
4. *B. inflata* spec. nov., from the Antarctic, depth not stated.

It is noticeable that this genus, which is only recorded from great depths in northern and temperate seas, is in the Antarctic regions found in comparatively shallow water.

The Antarctic forms agree with those described by Dr. Bergh in most points, but differ in several details, among which may be mentioned the presence of numerous papillæ along the dorsal margin and over the mouth. Unfortunately it is difficult to give a complete and satisfactory description of either, for *B. hodgsoni*, though well preserved internally, has probably been somewhat distorted externally, while *B. inflata* appears to be excellently preserved externally, but has no internal organs in a recognisable condition except the teeth and jaws. The two appear to be specifically distinct, as the radulæ are different and, as it would seem, the tentacles and branchiæ as well. *B. hodgsoni* is best characterised as having an armature of small black spines in the stomach and large solid tentacles at the side of the head. *B. inflata* has smaller, grooved tentacles, very small, easily detachable branchiæ, and comparatively few dorsal papillæ.

Dr. Bergh gives as a generic character *rhinophoria retractilia*. This is possibly a slip, for neither his descriptions nor his figures are quite decisive on the point. But there can be no doubt that in both of these species, and also in *B. abyssorum* (the specimen of which preserved in the British Museum I have examined) the rhinophores are not retractile, that is to say, there are no pockets into which they can be withdrawn.

### 4. Bathydoris hodgsoni (Figs. E–G).

One specimen captured in 100 fathoms off Coulman Island on January 13th, 1902, As preserved the colour is orange yellow of varying shades. Though the animal is not

at all transparent, the internal organs adhere to the rather thin skin and affect the colour in places. Length 41·5, breadth 28·7, weight 23 mm. The foot has a maximum breadth of 23 mm., and is only 23 mm. long, the rest of the ventral surface being taken up by the very large buccal parts.

The front of the foot is deeply grooved; the angles are not at all produced, at least as preserved, but the groove runs down for about 8 mm. on each side. The lateral and posterior margins are crinkled and drawn up against the body, but apparently formed a free projecting edge about 5 mm. wide. Posteriorly, this edge is prolonged into a short inconspicuous tail.

The dorsal margin does not project, but is clearly marked about 4 mm. above the foot by a line of papillæ, the largest of which are about 2 mm. high. They are detachable and leave behind them a mark like ⊙. A few under the rhinophores are larger and nearly 4 mm. long. These papillæ are most numerous near the dorsal margin, but it would appear from marks left that they once covered the whole dorsal surface, at intervals of two or three millimetres. There are also remains, especially near the margin, of a reticulate pattern formed by low whitish lines connecting the papillæ, but it is not conspicuous. The papillæ are rather irregular in outline, and taper abruptly, but are not ramified.

As preserved, the front of the animal is unlike *B. abyssorum* and *B. ingolfiana*. The dorsal margin of papillæ is continued anteriorly at a height of about 4 mm. above the lips. Above this margin rises a sort of forehead 7 mm. high, and bounded on the top by a thick ridge. It bears papillæ, and seems similar to the rest of the dorsal surface, from which it is divided by the ridge. The whole formation is possibly due to distortion. The lower side of each large lip is prolonged into a thick tentacle. The free part of the left tentacle, which is less contracted than the right, is 5 mm. long and 4 mm. thick at the base. These processes rise from the outermost corners of the head, not from the sides of the mouth, and should perhaps be regarded as flaps of the head rather than true tentacles; they are not grooved.

The rhinophores are bent, about 8 mm. long, and bear about thirty distinct perfoliations. Both have on the outside a groove across which the perfoliations extend. There is no trace of a pocket. At the base of each rhinophore is an inconspicuous flap of skin, but it looks like an unusually large perfoliation rather than a sheath. About 20 mm. from the head is a large prominence on which are seated the reproductive orifices. It lies just under the dorsal margin and is not surrounded by folds.

On the posterior slope of the body are the branchial tufts, eight in number, and arranged rather irregularly in an incomplete circle about 10 mm. in diameter and open behind. About 5 mm. behind the circle lies the large anal papilla, 4·5 mm. long and 3 mm. thick, with an irregularly crenulate margin. Within the circle lies the sub-central renal pore. The branchial tufts are composed of several (generally four) smaller tufts, each of which consists of two or three short, thick, coarsely bipinnate plumes.

When the dorsal skin is removed it is clear that there are no pockets into which

the rhinophores could possibly be retracted. The posterior part of the body cavity is filled by the large bluish-green liver on which lies the yellowish fern-like renal organ. Across the blue mass runs the yellowish intestine from left to right (rising from under the left side) and then backwards. In front lie the central nervous system and the genital mass, both yellowish. The hermaphrodite gland is completely hidden under the renal organ.

Though the internal organs are mostly well preserved, some have fared badly. The pericardium is represented by a thin, dried, pear-shaped membrane adhering to the dorsal wall from which it can hardly be detached. In front of the liver there lies over the pharynx a hard yellow mass consisting of two triangular lobes each measuring

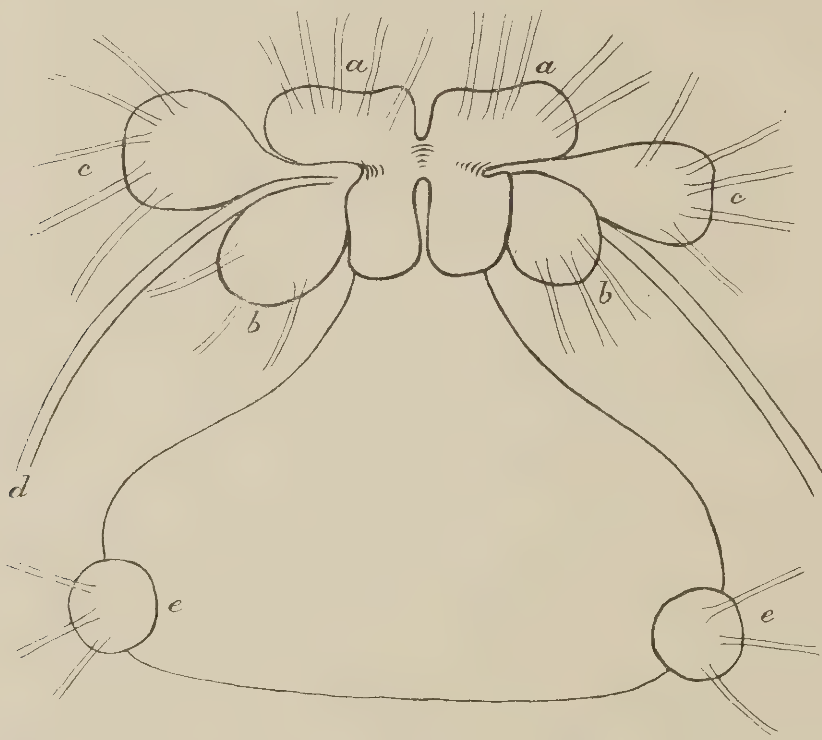



FIG. 12.—*Bathydoris hodgsoni*—CENTRAL NERVOUS SYSTEM: *a* CEREBRAL GANGLIA; *b* PLEURAL GANGLIA; *c* PEDAL GANGLIA; *d* COMMISSURE; *e* BUCCAL GANGLIA.

about 12 mm. × 10 mm. The central nervous system is embedded in this mass, which probably consists of the blood gland and the salivary glands fused together, but its character could not be more accurately determined.

The central nervous system (Fig. 12), which is well preserved, is much as described by Dr. Bergh for *B. abyssorum* and *B. ingolfiana*, and is remarkable for the separation and distinctness of the component ganglia. The cerebral ganglia are broader in front than behind, and notched on the outer side. The pleural are smaller and rounder, the pedal pear-shaped. The cerebral and pedal ganglia give off at least five nerves each and the pleural at least three. The buccal ganglia are round, and lie at the sides of the

pharynx, not beneath it. No trace of eyes or auditory organs could be found. The buccal mass is large (18 mm. × 15 mm.) and very strong. The front of it is formed by a thick muscular pad which lies over the jaws. These latter form a disc measuring about 14 mm. × 13 mm. as they lie together. The edges are rather membranous and yellow; the rest strong and deep brown. They are covered and united by strong membranes, and it would seem that they have no exposed cutting edge, but must act as a powerful prehensile organ.

The radula is set on a thick, tough, white membrane, from which the teeth are detachable only with difficulty. It consists of 37 rows, deep mahogany colour in front but rather lighter behind, which are unusually bent and curve upwards and outwards. In the longest rows there are as many as 65 teeth on either side of the

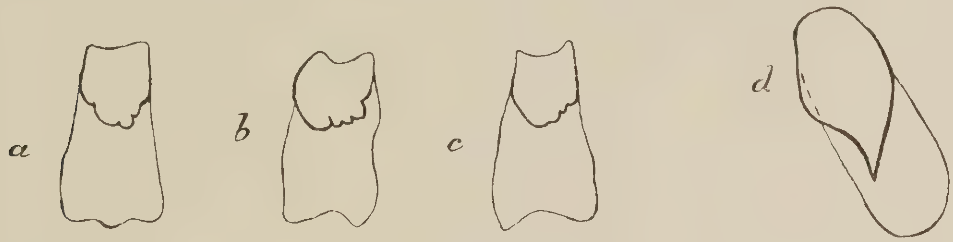



FIG. 13.—*Bathydoris hodgsoni*—THREE RHACHIDIAN TEETH, *a*, *b*, *c*.
FIG. 14.—*Bathydoris hodgsoni*—FIRST LATERAL TOOTH, *d*.

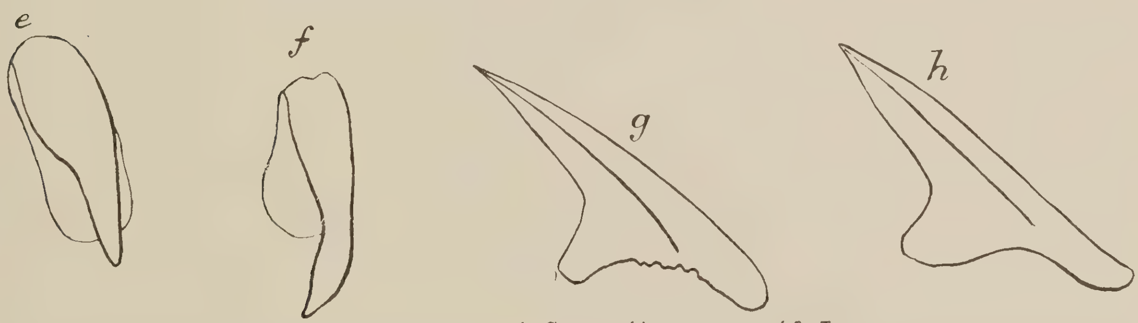



FIG. 15.—*Bathydoris hodgsoni*—SECOND (*e*), AND THIRD (*f*), LATERALS.
FIG. 16.—*Bathydoris hodgsoni*—LATERALS (*g* and *h*) FROM THE MIDDLE OF THE HALF ROW SEEN FROM THE SIDE; THE OTHER TEETH ARE SEEN FROM ABOVE.

rhachis. The ordinary laterals (Fig. 16) are spike-like and little bent. The base is deeply excavated and often jagged and there is a slight wing-like expansion at the side of the shaft. The fifth lateral from the rhachis begins to be flatter, lower and broader. These features increase markedly in the following teeth (Fig. 15), and the first lateral almost develops an accessory denticle (Fig. 16). The rhachidian tooth (Fig. 13) consists of a plate-like base rather broader behind than in front, and bearing a raised cusp of very irregular shape with several projections and indentations which are not sufficiently symmetrical to be called denticles. The 10–12 outermost laterals decrease rapidly in size, and the last two or three are rudimentary.

The œsophagus is about 7 mm. wide on issuing from the buccal mass. After dilating a little to form the first stomach the digestive tract turns sharply to the left

along the liver and goes under it. About the middle of the under surface of the liver the digestive tract dilates again to form the second stomach. After this point, when it must presumably be called the intestine, it runs up the left side of the liver, crosses its dorsal surface, and on reaching the right side turns backwards and runs to the hind part of the body. The liver is deeply grooved (in some places as much as 10 mm.) to receive the digestive tract.

The first stomach bears numerous strong longitudinal folds, which are themselves folded and puckered transversely. In the second stomach these folds cease, and are replaced by about ten low flat ridges, running into one another here and there, and by minute black spines arranged quite irregularly. These spines are conical, with round bases; some are thin and pointed, some thicker and rather blunt. At the exit from this stomach there are again longitudinal folds, and the intestine is lamellated transversely. The liver appears to enter this stomach by one large duct. No gall-bladder was found. The intestine contained black matter, which appeared to consist of mud and grit, including a pebble measuring 6 mm. by 4 mm. The animal no doubt swallows loose inorganic matter found on the sea bottom. The intestine is very large, being 8 mm. wide when it leaves the stomach and 5 mm. at its extreme posterior end; much of the work of digestion appears to be performed in it. The liver measures 30 mm. × 23 mm. It is smooth and undivided, except for the deep channel cut in it by the digestive tract. The hollow within it measures 8 mm. × 6 mm. The exterior surface of the liver is bluish green, but when it is cut the inside appears brownish, and is seen to consist of numerous tubes of an average width of 1 mm., although some are larger.

The renal organs are unusually developed. Adhering to the upper surface of the liver are two yellow fern-like organs, beautifully ramified. They lie side by side and together are 21 mm. long and 11 mm. broad. In the middle of them is a round transparent chamber with smooth membranous walls. The renal syrinx is large (5·5 mm. × 4·5 mm.) with strong foliaceous laminæ inside. A tube runs backwards from the renal organs along the intestine and issues in the renal pore within the branchial circuit.

The hermaphrodite gland lies under the renal organs and touches the anterior part of the liver. It is nearly circular (8 mm. × 7 mm.) and has a large strong duct. It is composed of spherical globules, yellowish with white rims. They contain minute granules, some circular and some elongate. The anterior genital mass is very small, and the animal is probably sexually immature. The mucous gland is yellowish; the albumen gland is roundish and darker yellow. The spermatotheca and spermatocyst are both rounded, flattened and very small. The vas deferens is an extremely thin tube coiled about seven times. The verge is completely retracted into a bag and much crumpled, but appears to be relatively large. On one side there is a deep fold, probably corresponding to the cleft observed by Dr. Bergh in other species.

The armature of spines in the stomach is remarkable and is not found in any nearly allied genera, though it occurs in *Bornella*.

### 5. Bathydoris inflata (Fig. D).

One specimen, labelled W.Q. Feb. 1902. The distended egg-shaped body projects considerably over the head in front so that the length dorsally is 17 mm., whereas the length from the mouth, which is ventral, to the tip of the tail is only 13 mm. The breadth is 12·5 mm. and the height 11·5 mm. The colour is dark chocolate of various shades, the internal organs being visible through the skin as in the last species. The rhinophores, tentacles, branchiæ, foot and marginal papillæ are yellow. The few remaining dorsal papillæ are whitish.

The foot is 9 mm. broad and only 10 mm. long. It is grooved in the same way as the last species and has a projecting lateral margin about 3 mm. wide. The tail is short.

The dorsal and marginal papillæ are much as in the last species, but there is no reticulate pattern. They are sparsely scattered over the back, there being only about twenty facets on the dorsal area visible from above. They are most numerous near the margin, especially over the head, where they form a sort of oral veil. Most of them are irregular in shape with various bulges and wrinkles, but a few near the rhinophores are straight and as much as 4 mm. long.

The mouth is open and bears on each side a pointed conical tentacle, which is deeply grooved near the base and about 3·5 mm. long.

The rhinophores are straight, 3·5 mm. long, and bear about twenty distinct perfoliations. There is no trace of a pocket.

The branchiæ are five or six in number, according as the anterior group, which consists of two plumes close together, is counted as one or two. The rest are single, and not tufts composed of several plumes. They are tripinnate but minute, being not more than 1 mm. broad, and easily detachable. Within the branchial circuit is a small sub-central renal opening. Behind is the anus, which is not very prominent.

The interior of the animal is almost entirely filled with a solid mass composed of fragments (some as large as 8 mm. by 7 mm.) of a semi-transparent, reddish-brown substance, resembling horn or hardened glue. The state of the œsophagus, which is lined with this substance, suggests that the animal must have distended itself by swallowing some kind of jelly which, under the action of the preserving fluid, hardened into an almost vitreous mass. The colour of the integuments is due to this substance, and, when removed, they are transparent and very brittle. Most of the internal organs have been distorted and hardened out of all recognition. Besides the buccal mass can be distinguished only the outline of the fern-like kidney and of the intestine, which are compressed against the dorsal wall, and some hard fragments of the œsophagus, liver, hermaphrodite and mucous glands.

The jaws lie in the fore part of the buccal mass, and form a disc about 3 mm. in diameter, covered by strong membranes, which are pierced by an aperture ·7 mm. wide. In structure they resemble the jaws of the last species. The radula consists of twenty-two rows, and the teeth are deep yellowish brown. They increase regularly in number

backwards, so that the whole radula is fan-shaped. The front rows contain ten to fifteen teeth on each side of the rhachis, the middle rows fifteen to twenty-five, and the back rows twenty-five to thirty. The central tooth (fig. 17) is much broader than in the last species. In the front rows it is distinctly bifid, and the laterals close over it, but, as the rows widen, it becomes separated from the laterals by a distinct space and the cusp is irregularly indented. The outlines of the base both of this tooth and of others are very indefinite, and seem to melt into the membrane which bears the radula.

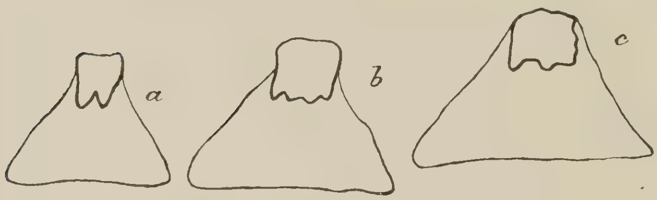



FIG. 17.—*Bathydoris inflata*—RHACHIDIAN TEETH.

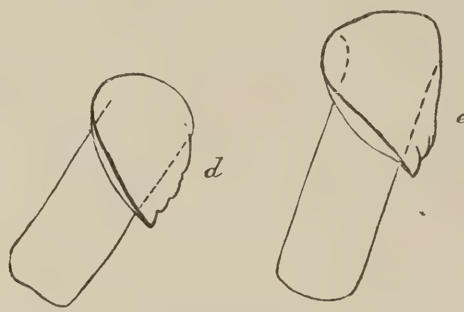



FIG. 18.—*Bathydoris inflata*—TWO FIRST LATERALS.

The first lateral (fig. 18) bends towards the rhachis, and has a long base and a low flattened hook bearing one distinct denticle and an irregularly jagged edge on the inner side. The second lateral (fig. 19) has a squarer base, and the hook, though narrower, is still flattened, and bears a distinct terminal denticle. The third lateral (fig. 20) is much the same, and the rest gradually become straighter and more erect until the sixth or seventh attains the form which prevails until the end of the row. The teeth near the rhachis are flatter and more different from the rest than in


FIG. 19.—*Bathydoris inflata*—SECOND LATERAL.

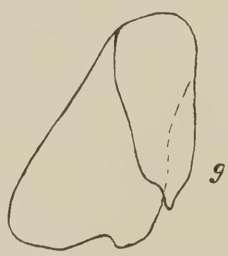



FIG. 20.—*Bathydoris inflata*—THIRD LATERAL.

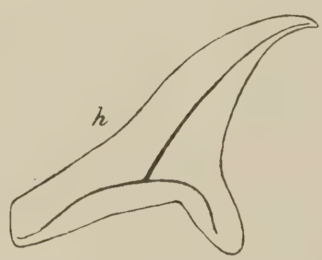



FIG. 21.—*Bathydoris inflata*—LATERAL FROM THE MIDDLE OF HALF ROW.

*B. hodgsoni.* The laterals (fig. 20) in the middle of each half row are stoutish but fairly erect. They often have the extreme tip bent, and bear a wing-like ridge at the side. The four or five outermost are rudimentary.

As mentioned above, in spite of the differences in the dentition, branchiæ and other points, I do not think it impossible that this may be a younger specimen of *B. hodgsoni.* Owing to the condition of the internal organs, it is impossible to say if the stomach was armed with spines or not.

## DOTO (Oken).

The members of this genus are small animals, probably of cosmopolitan distribution. They are recorded in abundance from the Northern and Median Atlantic (Cape Verde Islands) and the Mediterranean, and also from Mauritius, Zanzibar, Ceylon, and Formosa. A great number of species have been described, especially by Trinchese and Hesse, but the majority are uncertain, as it is hard to find good specific characters. The buccal parts and other internal organs are much the same for all species, and not only the colouration, but such characters as the shape of the rhinophore sheaths, frontal ridges, and tubercles vary within the limits of one species. Dr. Bergh recognises sixteen species in his "System der Nud. Gasteropoden," but of these *D. arbuscula* Agassiz and *D. minuta* Forbes appear to be mere names, and *D. australis* Angas is probably a *Melibe.* To the list may be added *D. africana* Eliot (P.Z.S., 1904, page 285), *D. annuligera* Bergh (Siboga Exped. Opisth., 1905, page 221), and *D. floridicola* Simroth (Archiv. für Naturgeschichte, 1888, Vol. I., page 219), though the last (the radula being unknown) may perhaps be identical with Bergh's *Dotilla pygmaea.* *Doto crassicornis* is recorded from Christiania, so the genus is probably found in Arctic seas.

### 6. Doto antarctica, sp. n. (? = D. fragilis var).

One specimen labelled "25.2.02., Seal crack W.Q. 45." The body is 11 mm. long, 4 mm. high, and 3 mm. broad, without the cerata, the largest of which is 5 mm. high and 2·5 broad. The colour as preserved is a uniform deep bright yellow, except that the tips of the tubercles on the cerata are paler. The surface of the body is smooth, and there are no tubercles on the back or sides. From the marks left on the skin, it would appear that there were originally six pairs of cerata, but only six single cerata have been preserved. They are erect, tall, but not very stout, and bear four to five rows of distinct pointed tubercles. In the top row there are four tubercles, in the lower as many as eight. The facets of the cerata, which have been removed, show three distinct openings, one for a ramification of the liver and two for the vascular system. The foot is broad and rather paler than the body. The frontal veil is ample, rounded in front, and bears two ridges running to its edge from the front of each rhinophore sheath. These sheaths are 2 mm. high. Their margin is divided into four lappets, of which the most anterior is conspicuously larger than the others, and projects 1·3 mm. in front. The rhinophores are rather stout and quite smooth, without wrinkles. The genital opening is under the place where the first of the cerata apparently stood and the anal papilla at the right anterior extremity of the pericardium, between the first and second cerata.

No jaws were found, but these organs are probably not absent. In this genus they are extremely thin and membranous, so that, except in large and well preserved specimens, they are very apt to become torn or decayed, and so escape notice. The radula is a single row of 102 clear yellow teeth of the shape usual in the genus.

They bear three to four distinct lateral denticles, the highest of which are on the sides of the central cusp.

This species is nearly allied to *Doto fragilis* (Forbes), which has ridges on the frontal veil and no dark spots. But the cerata are fewer, and bear fewer tubercles, there are no traces of tubercular spots on the back, and the rims of the rhinophore sheaths are much more deeply and distinctly lobed than in *D. fragilis.* These characters, however, are all rather slight, and on examination of several specimens would probably show considerable variation. *Doto aurea* Trinchese (? = *D. aurita*, Hesse), has deeply lobed rhinophore sheaths, but apparently no ridges on the veil.

Provisionally this form may be registered as *Doto antarctica,* but it does not differ materially from the Dotos of the North Atlantic, unless indeed jaws are really absent.

## NOTAEOLIDIA (Eliot).

Eliot, Nudibranchiata of the Scottish National Antarctic Expedition ; Trans. Royal Soc. of Edinburgh, XLI., Part III. (1905), p. 520.

This genus, which was created by me for a number of specimens collected by the Scottish Antarctic Expedition from the South Orkneys, seems characteristic of Antarctic waters. It is intermediate between the Aeolididæ and forms like *Dendronotus* and *Lomanotus.* Like the true Aeolids, it has non-retractile perfoliate rhinophores without sheaths, large oral tentacles, but no frontal veil, and numerous cerata, but the radula consists of a few rows each containing nine or eleven teeth, and the liver is a folliculate mass, partly lying within the body cavity and partly forming a layer within the body walls, from which branches pass into the cerata. The species are :—

1. *Notaeolidia gigas* Eliot.
2. *N. purpurea* Eliot.
3. *N. depressa.* Sp. nov.

*N. gigas* and *N. purpurea* superficially resemble Aeolids. In the present species the resemblance is less striking, as the animal is relatively broader, flatter and furnished with only a single row of cerata. The radula is specifically distinct.

### 7. Notæolidia depressa (Figs. H and I).

One specimen from McMurdo Bay, dredged in 4 to 10 fathoms, and, as preserved, of a uniform, orange yellow, with a little white pigment on the papillæ. It measures 47·5 mm. in length, 16 in breadth, and 12 in height, but has a flattened and depressed appearance, owing to the sides of the back being produced, much as in *Lomanotus,* into expanded margins, which bear a single row of conical papillæ, accompanied in a few places by very small ones underneath. The majority of these papillæ or cerata are about 1·5 mm. high, but some are still smaller ; and on each side there are about fifteen larger ones, 5 to 8 mm. high, set at

irregular intervals. In all there are about ninety on each side. They are somewhat wrinkled, and this rugose appearance is increased by their bearing a little white pigment, arranged in irregular lines. In front the side-flaps turn inwards, so that the cerata stand in front of the rhinophores; but they are set distinctly on the flap, and not on the head. Behind, the cerata of the two sides meet at the tip of the tail, the free portion of which is very small and hardly 1 mm. long. The dorsal margin and cerata are irregularly undulated.

There is no frontal veil, but the region in front of the rhinophores passes directly into two very thick, conical, oral tentacles, 6·5 mm. long, and 5 broad at the base. Between them lies the mouth, which seems small and circular, but is much contracted. The anterior margin of the foot is grooved, and perhaps notched; but this character could not be ascertained with certainty, owing to contraction. The foot is folded inwards, but in a natural condition must have had wide, expanded margins, and have been about 10 mm. broad. The rhinophores, which are set close together, are about 4·5 mm. high, and bear fifteen distinct perfoliations. At the base are folds of skin, but not regular pits. The genital orifices are 13 mm., and

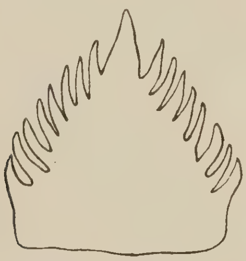


Fig. 22.—*Notaeolidia depressa*—Rhachidian Tooth from above.

Fig. 23.—*Notaeolidia depressa*—Rhachidian Tooth from the side.

the vent 20 mm. from the head. The former are small, and not surrounded by large folds of skin; the latter is an elongate papilla, half way down the side. The pericardium is not prominent.

The internal organs are poorly preserved, but appear to resemble those of *N. gigas* in their essential features. The central nervous system is small, the eyes black and minute. No salivary glands were discovered, but they probably exist. The jaws are thin, with a smooth edge. The formula of the radula is 20 × 4.1.4, and the teeth are much as in *N. gigas*, but the central tooth (figs. 22 and 23) is not so square, and has sloping sides. It has a rather lower median cusp with eight to nine strong denticles, but is not striated. The laterals are higher and narrower, with deeper and more distinct denticulations. Even the outermost lateral has about twelve fine but clear denticulations. The œsophagus is short, the stomach large, strongly laminated, and constricted in the middle. The liver is folliculate, and arranged much as in *N. gigas*. The main trunk gives off six branches on each side, which form a layer of ramifications in the mantle margin and sides of the dorsal area, from which diverticula pass into the cerata. The space filled by this layer is considerably

larger than the line of the cerata, and the reddish ramifications are clearly visible through the skin. The diverticula within the cerata, on the other hand, are only visible with difficulty, being of the same colour as the integuments as preserved. In structure they are similar to the same organs in *N. gigas.*

FIG. 24.—*Notaeolidia depressa*—*a* FIRST LATERAL TOOTH; *b* SECOND; *c* THIRD; *d* FOURTH.

The reproductive system is not much developed, and the animal, considering its relatively small size, is probably sexually immature. The follicles of the hermaphrodite gland lie among the hepatic branches, but do not form a thick mass above them, as in *N. gigas.* The anterior genital mass is small and yellow, the spermatotheca of moderate size and roundish, the vas deferens long and much convoluted.

## CRATENIDAE.

(See Eliot, Jour. Mar. Biol. Assoc., VII. (1906), pp. 363–366.)

THE division into genera of the forms comprised in Dr. Bergh's family Cratenidae is a matter of great difficulty. *Phestilla* is distinguished by its dentition among other points, and *Hervia* by its elongate shape; but *Cuthona*, *Cuthonella*, and *Cratena* are not easily separated from one another. None of them have any very remarkable characteristics; they are smallish Æolids, neither very long nor very stout, with simple rhinophores, cylindrical cerata, a foot rounded in front or with inconspicuous projections, and teeth of the common horse-shoe shape, bearing a moderate number of denticles (usually less than twelve) on each side of a central cusp.

In Jeffreys' "British Conchology," Vol. V., Alder divided many of the forms comprised in these genera between *Cuthona*, having the branchiæ close set, and *Cavolina*, having them in rather distant rows, and also having the central cusp of the teeth a little prominent. But the name Cavolina is preoccupied, and the difference between close set and distant rows is one of degree, which may be obscured in preserved specimens. According to Dr. Bergh's definition, the difference between *Cuthona* A. and H. and *Cratena* Bergh is very slight. The former has *caput latum . . . podarium antice rotundatum*, the latter, *caput non latum, podarium antice leviter arcuatum.* *Cuthonella* Bergh is more distinct. The foot has pointed corners in front, the jaws bear several series of denticles, the anus is latero-dorsal, and the otocysts

contain otoconia, not a single otolith. These characters, though occurring in *Cuthonella abyssicola*, for which Bergh created the genus, have not been found united in any other form, and Dr. Friele ("Mollusken der ersten Nordmeerfahrt," Bergen's Museums, Aarbog, 1902, No. 3, page 9) has enlarged the definition, treating the dorsal position of the vent as the chief character, the shape of the foot, denticulation of the jaw and presence of otoconia being regarded as of secondary importance. Following this example, I refer to *Cuthonella*, three forms in the present collection, and the genus will now comprise the following species :—

1. *Cuthonella abyssicola* Bergh.
2. *C. ferruginea* Friele.
3. *C. berghi* Friele.

} All from the North Atlantic in considerable depths.

4. *C. antarctica*, sp. nov.
5. *C. modesta*, sp. nov.
6. *C. paradoxa*, sp. nov.

The arrangement of the cerata in the last-named species appears to have been very remarkable, and might warrant the creation of a new genus, but the specimen is unfortunately damaged.

### 8. Cuthonella antarctica.

One specimen labelled "W. Q. 5. vi. 02. D net," uniform yellowish brown in colour and fairly stout. The body is 14 mm. long and 6 mm. broad across the pericardium, without the cerata. These latter have an irregular appearance, as they point different ways, but are set in seven rows on each side, containing four to six each.

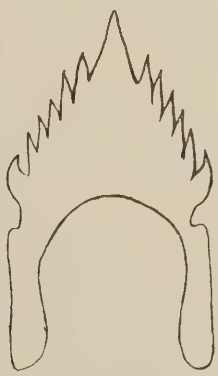


Fig. 25.—*Cuthonella antarctica*—A Tooth from above.

Fig. 26.—*Cuthonella antarctica*—A Tooth from the side.

There are six in the first row. The innermost are the largest (5–6 mm. high), and the outermost are very small. After the seven rows comes a clump of very small cerata on the tail. The genital orifices lie below and between the first and second rows. The vent is latero-dorsal, and lies at the right posterior extremity of the pericardium close to the innermost cerata of the fourth and fifth groups. The first is rounded in front without a trace of tentacular angles. The mouth, as preserved, is ventral, and

has on each side of it a short, thick, blunt tentacle. The rhinophores are much larger than these tentacles (4·7 mm. high), wrinkled but not perfoliate. The back is strongly arched, and shows a clear central space, 3–4 mm. wide, without any cerata. The head and the foot are of about the same breadth, 4·5 mm.

The jaws are brown and hard, enclosing the buccal mass. The masticatory process bears a single row of very irregular projections of varying shapes, with little lumps behind them, but there cannot be said to be any regular denticles. The radula consists of a single row of twenty-six brown teeth (figs. 25 and 26). They are of the horse-shoe shape with a fairly strong central cusp, and six, or rarely seven, lateral denticles. The outermost denticle is curved strongly inwards. The others are fairly straight.

### 9. Cuthonella paradoxa.

One specimen from Winter Quarters, captured February 20th, 1902. It is yellow with traces of reddish brown and some minute reddish dots on the larger cerata. The intestines and hepatic diverticula, as seen through the integuments, are reddish brown.

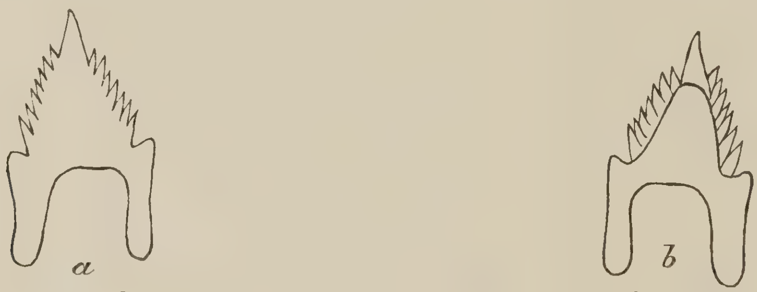



Fig. 27.—*Cuthonella paradoxa*—A Tooth; *a* From above; *b* From below.

Length, 11 mm., breadth, 8 mm., height, 4·3 mm. The pointed tail, as distinct from the dorsum, is 2·3 mm. long.

The oral tentacles are 2 mm. long, and point straight right and left. The rhinophores are 3 mm. long, stout, bent forwards and bear transverse rings, but it is not clear if these rings are natural or the result of contractions.

On the left side is a single line of twelve cerata along the dorsal margin, none more than 1 mm. high, conical, with gaps between them, so that the line is probably not complete. Within this line there remains still attached a single very large papilla about 7 mm. long and rather bent. It is behind and slightly to the left of the anal papilla. On the right-hand side is a similar line of twelve cerata, mostly rather larger. Under the first three of them is a second row of three very small ones. In the bottle are seven detached cerata measuring 7, 5, 5, 4, 4, 3, 2 mm. respectively. The anal papilla is dorsal, set far back (7 mm. from anterior end) and slightly to the right of the median line. The genital orifices are 4 mm. from the anterior end, rather high up on the side.

The anterior end of the body forms a hood over the mouth which, as preserved, is ventral. The foot is rounded in front, thickened at the margin and slightly expanded,

but not grooved and not produced into tentaculiform angles. The internal organs are somewhat decomposed, but appear to be as is usual in the Aeolididæ. The jaws are thin and yellow, with a single row of distinct denticles, some pointed and some blunt. The uniseriate radula consists of thirty-one reddish-yellow teeth (fig. 27), with seven distinct fairly stout and long denticles on each side of the central cusp.

The hepatic diverticula are irregular in outline, and the reddish dots appear to be on them and not on the external surface of the cerata. The cerebro-pleural ganglia are roundish, and considerably larger than the pedal ganglia. The olfactory ganglia are round and close together. An auditory organ was not found. The hermaphrodite gland consists of large and small lobes. No armature was discovered on the verge. The animal cannot be safely reconstructed from the fragments preserved, but it certainly looks as if it had had a fringe of small cerata round the dorsal area, and a few much larger ones grouped round the vent.

### 10. Cuthonella modesta.

One small specimen of a uniform greenish yellow, labelled "W.Q., 1, XII., 02., D net, Hut point, 123, Picric acid." As preserved it is only 3·2mm. long and 1·1 broad. The cerata are stoutish and rather inflated; the tallest are less than 1mm. high, the smallest are mere tubercles. They are very deciduous, and most have fallen off, but apparently there were only two longitudinal rows on each side. The pericardium is large; to the right of it lies the anus, which is latero-dorsal. The genital orifices are just behind the rhinophores. The rhinophores are large, thick and simple, the oral tentacles short and thick. The foot is broad with expanded lateral margins and a thick anterior margin produced into short processes on either side.

The jaws are white and membranous. The masticatory edge is not even, but can hardly be said to bear denticles. The radula consists of a single row of 27 teeth, yellowish, and of horse-shoe shape. They bear five denticles on each side of the central cusp, which is low and shorter than the lateral denticles, so as to be hardly visible.

### (?) 11. Cratena sp.

Label, "W.Q., 29 v. 03., No. 4 Hole, 5 fms." The tube sent with this label was said to have contained "four minute Aeolids," but, unfortunately, it was received in a broken condition and its contents were dry. There were found in it only the shrivelled remains of one aeolidiform animal, whitish, 5mm. long and 1·5mm. wide. Nothing could be distinguished externally except the tentacles and two or three longish cerata.

The jaws are transparent, with a single row of large, distinct, but rather irregular denticles. The radula is uniseriate, and consists of 15 colourless teeth of the narrow horse-shoe shape, with a long, strong central cusp and five clear-cut, longish denticles on each side.

This animal is very probably a *Cratena*, but identification is impossible.

## GALVINELLA.

This genus agrees with *Galvina* in its dentition, which is an important point of resemblance, but differs so much in other ways that it can hardly be included in the same genus. The anterior corners of the foot are produced and pointed, the vent is medio-dorsal and the cerata, though they have inflated tips, are not ovate as in *Galvina*, but slender and bent. A few of them stand isolated near the centre of the back.

The allied genus *Galvina* is common in the North Atlantic and *G. rupium* is recorded from Greenland.

### 12. Galvinella antarctica (Figs. J and K).

One specimen from Winter Quarters, "Hole No. 11, rim," captured April 24th, 1903. It is rather stout and of a uniform yellow colour. Length 20 mm., breadth across tips of cerata 8 mm., across the back 6 mm., height 5 mm. The foot is much crinkled, but appears to have been about 4 mm. wide. It is grooved in front and produced into short, straight tentacular angles.

Fig. 28.—*Galvinella antarctica*—Cerata.

The oral tentacles are short and thick, 3 mm. long and 2 mm. broad at the base. The rhinophores are longer (5 mm.), somewhat dark and thick towards the apex. Both the tentacles and rhinophores are wrinkled, but apparently not really perfoliate.

The cerata (Fig. 28) have an unusual appearance owing to their standing a considerable distance from one another and pointing different ways. They are mostly bent, thick at the base and again thick at the apex, but rather slender in the middle. The arrangement appears to be as follows when one looks at the complete specimen :—

| Left side. | | Right side. |
|---|---|---|
| 5 | | 5 |
| 4 | | 5 |
| 6 | | 6 |
| 6 | | 6 |
| 5 | | 5 |
| 5 | | 4 |
| 3 | Middle. | 3 |
| | 11 | |

But an inspection of the facets after removing the cerata leads to the conclusion that the anterior group is a horse-shoe, or two lines inclined towards one another,

followed by eight simple lines of three to six cerata each. The outermost cerata are small, cylindrical and straight; the inner are 5–6 mm. high, and nearly always curved almost into a semicircle. Four of the cerata stand in the middle of the back, two in front of the pericardium and two behind. Though a few of them have been lost, they are not caducous.

The anus is a prominent medio-dorsal papilla, standing just behind the pericardium and after the fourth row of cerata. The jaws are thin and yellowish. They are not denticulate, but present near the edge an appearance like a tessellated pavement due to numerous short prominences. The radula consists of sixty-four rows containing three teeth each. The central tooth (fig. 29) bears a median cusp, and on each side of it four denticles, of which the fourth is less conspicuous than the others and sometimes absent. The median cusp is fairly strong, but rather low and points straight forward, whereas the first of the lateral denticles often points distinctly upwards. The side denticles are fairly long but a little irregular in shape and direction. The lateral teeth

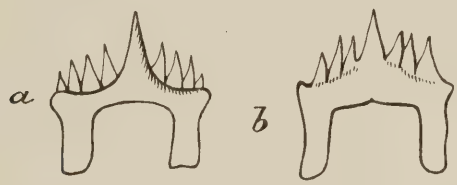



FIG. 29.—*Galvinella antarctica*—CENTRAL TOOTH; *a* FROM BELOW; *b* FROM ABOVE.

FIG. 30.—*Galvinella antarctica*—LATERAL TEETH.

(fig. 30), are much as in *Galvina*, very thin and transparent but distinct. The base is very long and bears a single pyramidal cusp, the tip of which is often broken off.

The rest of the digestive system appeared to be as usual. The salivary glands are long, simple bands. Flocculent ptyaline glands also seem to be present. The central nervous system is as usual. The cerebro-pleural and pedal ganglia are both spherical, the latter distinctly below the former. The olfactory ganglia are elliptical. The eyes, which are black with yellow lenses, are set far back on the cerebro-pleural ganglia. The reproductive system also appeared to be as usual. The hermaphrodite gland is not large, but the lobules which compose it are very distinct and consist of small spherical bodies set round a large one. The verge is long, conical and unarmed.

## DESCRIPTION OF PLATES.



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## DESCRIPTION OF FIGURES.


Antarctic (Discovery) Exp.

Nudibranchs.

A. J. E. Terzi, del. Butterworth, sc.

# MOLLUSCA.

## V.—LAMELLIBRANCHIATA.

By Edgar A. Smith, I.S.O.

(Plates II. and III.)

### Cuspidaria tenella.

(Pl. II., figs. 14, 14a.)

Shell rather large, very thin, considerably convex, broadly rounded in front, narrowly or rather shortly rostrate posteriorly, whitish, covered with a thin periostracum, sculptured with distinct lines of growth and concentric waves; inner surface smooth, but concentrically sulcate, the shallow sulci corresponding with the external waves; dorsal margin of right valve delicate, with a small ligamental pit (see fig. 14a) directed obliquely backwards beneath the umbo, a raised ridge extends from this ligamental process, parallel with the edge of the valve, and might be regarded as a posterior lateral tooth; adductor scars and pallial sinus indistinct.

Length, 30 millim.; alt., 22; diam., 15.

Off Coulman Island, 100 fathoms.

This is a large species, but very thin, and somewhat resembles *C. optima*, Sowerby, from South Africa. It is, however, somewhat different in form, is much more delicate in substance, and the ligamental pit and hinder lateral tooth are different. Only a single right valve was obtained.

### Anatina elliptica.

(Pl. III., fig. 3.)

*Anatina elliptica*, King and Broderip: Smith, 'Challenger,' *Lamellibranchiata* (1885), p. 76; id. 'Southern Cross,' *Mollusca*, p. 210, pl. xxv., figs. 9, 10.

Winter Quarters, 10–130 fathoms.

To show the variation in form, a figure is now given of a short example, which is very different from that figured in the 'Southern Cross' report.

### Thracia meridionalis.

*Thracia meridionalis*, Smith, *Lamellibranchiata*, 'Challenger' Exped., p. 68, pl. vi., figs. 4–4b.

Holes 4, 12, etc., 20–130 fathoms.

The largest specimen obtained exceeds the dimensions of any of the 'Challenger'

examples. It is 26·5 millim. in length and 21 in height. The form is rather variable, some shells being much longer in proportion to the height than others. The species was obtained by the 'Challenger' at Kerguelen, Marion and Prince Edward Islands.

### Cardita astartoides.

*Cardita astartoides*, Martens; Smith, *Lamellibranchiata*, 'Challenger' Expedition, p. 212, pl. xv., figs. 2–2c.

Winter Quarters, 130 fathoms.

Only young and half-grown specimens were obtained. They do not exhibit any special difference from the Kerguelen examples, excepting that, in some of them, the radiating riblets are rather more distinctly granose, through the more strongly marked concentric striæ.

### Cardita antarctica.

(Pl. II., figs. 15, 15a.)

Shell small, very inequilateral, moderately convex, dirty whitish, covered with a thin olivaceous periostracum, sculptured with about 24 radiating riblets, which are a trifle broader than the interstices, and ornamented with fine concentric waved striæ, some of which are more strongly marked at intervals; lunular and escutcheon areas exhibiting only growth-striæ; umbones curved over anteriorly almost to the end of the shell; hinder dorsal margin a little oblique, subrectilinear, anterior very much descending; ventral outline broadly arcuate, posterior a little curved; interior of valves white, slightly dentate at the margin; front adductor scar long, narrow, deepish, posterior much broader. A slight ridge commencing at the upper end of the anterior impression curves upwards towards the umbo; hinge normal.

Length, 12 millim.; height, 12; diam., 10.

March 4, 1904, near Antarctic Circle, 254 fathoms, mud and stones.

Only a single left valve was obtained. The lines of growth on crossing the radiating riblets are sufficiently strong to produce a compressed subgranose appearance upon the younger portion of the shell.

The species is more inequilateral than *C. velutina*, Smith, from Patagonia, not nearly so strongly ribbed, the ribs being more numerous and less distinctly granose. The inner margin of the valves also is not so coarsely dentate.

### Kellia simulans.

(Pl. III., fig. 1.)

Shell small, inequilateral, roundly ovate, rather swollen, subpellucid, whitish, glossy, sculptured with fine striæ of growth and a few rather inconspicuous radiating striæ, chiefly down the middle of the valves and near the ventral margin; anterior end more sharply curved and narrower than the posterior, lower outline very gently arcuate; umbones antemedian, curved over to the hinge-line, rather obtuse at the apex; interior of valves faintly waved in the direction of the lines of growth,

glossy; hinge composed of two small cardinal teeth beneath the umbo in the left valve and one in the right, also a long posterior lateral in each valve; a very slender ligament is attached to the margin of the valves behind the umbones; the internal ligament has apparently dropped off.

Length, 6 millim.; altitude, 5; diam., 3·5.

Hut Point, Oct. 25, 1902.

One specimen only. Differing in form from *Kellia magellanica*, Smith. Also somewhat resembling the British *K. suborbicularis*, Montagu, yet different in shape, and having a more delicate hinge.

### Tellimya antarctica.

(Pl. II., figs. 16–16b.)

Shell very small, transversely ovate, rather convex, inequilateral, white, covered with a dull yellowish periostracum, marked with very fine incremental lines; anterior side much shorter than the posterior, rounded; ventral outline broadly curved; umbones antemedian, only a little prominent, somewhat eroded; hinge consisting of two strong cardinal teeth in the left valve (fig. 16b, 1), none in the right; ligament central, beneath the umbones (figs. 16a–b, 2); interior of the valve smooth, but exhibiting lines of growth; margin smooth, slightly thickened; posterior adductor scar pyriform, anterior apparently smaller.

Length, 3 millim.; height, 2·5; diam., 1·5.

Hut Point, Feb. 13, 1904.

Only one specimen was obtained. Short, and more solid than the northern *T. bidentala*, Montagu, also having a stronger hinge.

### Cyamium denticulatum.

(Pl. III., figs. 4–4b.)

Shell small, rounded, rather convex, almost equilateral, rather thin, whitish, covered with a very thin, glossy, yellowish periostracum, marked with very fine striæ of growth and numerous shallow, narrow, and not very conspicuous radiating sulci or impressed lines. The latter are visible on the inner surface of the valves, which are finely denticulate at the margin; the muscular impressions are indistinct. Hinge composed of two diverging teeth in the right valve (fig. 4b, t.), and three in the left (figs. 4a, t.), the anterior in the right and the central one in the left being somewhat bifid. The posterior lateral margin of both valves is produced into a pseudo-lateral tooth (figs. 4a, 4b, m.); the ligament (figs. 4a, 4b, l.) is oblique, posterior to the teeth, and mostly internal; but a slight portion is visible externally, when the valves are closed, just behind the tip of the umbones; the prodissoconch forms a circular, smooth, glossy, white, convex disc at the apex of each valve.

Length, 4·3 millim.; height, 4; diam., 3.

Hole 3. In 12¾ fathoms, stones and gravel.

Although the general aspect of this species is very unlike that of the type of the genus *Cyamium*, still the characters of the hinge appear to be so very similar that it does not seem to be advisable at present to separate them generically.

### Diplodonta incerta.

(Pl. III., figs. 5, 5a.)

Shell very inequilateral, small, thin, whitish, moderately convex, sculptured with fine lines of growth, and exhibiting a radiating ridge or rounded angle from the umbo to the lower posterior extremity; umbo antemedian, consisting of a distinctly marked, smooth, pellucid, convex, rounded embryonic disc; anterior dorsal margin much descending; posterior curved, horizontal, posterior end terminating below in a point at the end of the radiating ridge; anterior end sharply curved; lower margin gently arcuate; interior smooth, glossy, exhibiting a groove beneath the exterior radiating angle, and some shallow sulcations corresponding with the more distinctly marked lines of growth of the exterior; two divergent cardinal teeth in the right valve (fig. 5a, 1), the anterior one being just in front of the apex of the umbo, and the posterior immediately beneath it; ligament internal (fig. 5a, 2), in a narrow furrow behind the hinder tooth; scars and pallial line indistinct.

Length, 6·75 millim.; height, 5·5; diam., 5.

Winter Quarters, 130 fathoms.

One right valve only. Provisionally placed in *Diplodonta*, although the ligament is rather more wholly internal than in that genus.

### Philobrya limoides.

(Pl. III., figs. 2–2b.)

Shell small, equilateral, moderately convex, thin, dirty whitish, clothed with a deciduous, fibrous periostracum, sculptured with concentric lines of growth and some raised, slender, radiating, threadlike lines, from which spring short, epidermal hairs or fibres of a darker colour than the rest of the epidermis; umbones obtuse at the apex, which consists of a distinct protoconch, radiately lirate, minutely concentrically striated, and having a straight hinge-line; the dorsal margins of the adult shell are very sloping, nearly rectilinear, the posterior grooved to hold the ligament (figs. 2b, 1), and the anterior terminating just in front of the umbones of both valves in a small, shelly projection; lateral and ventral margins more or less distinctly denticulate within and slightly thickened; interior of valves dirty whitish, smooth, exhibiting a large but shallow posterior adductor scar in the form of a 6; anterior scar not traceable, perhaps absent.

Length, 8 millim.; height, 9·5; diam., 4·5.

Winter Quarters, 20–130 fathoms.

Remarkable on account of the peculiar protoconch, the epidermis, and the

bristle-bearing, radiating lines. Only the slightest chink exists in front of the umbones for the passage of the byssus. In form somewhat resembling, in miniature, that of the large northern *Lima excavata.* Differing from *P. sublævis*, Pelseneer, in the position of the ligament and the absence of crenulation on the hinge-plate, and in the character of the prodissoconch, as well as the position of the adductor scar.

### Adacnarca nitens.

(Pl. III., figs. 6–6c.)

*Adacnarca nitens*, Pelseneer, Voy. Belgica, Mollusca (1903), pp. 24, 41, pl. vii., figs. 83–88.

Beyond a slight difference in form, which seems to be a variable feature, judging from the few specimens obtained, there does not appear to be anything to distinguish these examples from that figured by Prof. Pelseneer. This genus, consisting at present of a single species, has a small, obliquely-rounded shell, of thin texture, glossy, minutely radiately striated, of a dirty whitish colour, covered with a thin periostracum. The edge of the valves within is minutely crenulated, the crenulation at the sides being rather stronger than upon the ventral margin. The hinge consists of a minute central resilium, beneath the beaks (figs. 6c, 1), a slight marginal ligament (figs. 6c, 2), and a minutely, transversely striated hinge-plate (figs. 6c, 3). The largest specimen is 7 millim. in length, 6·5 high, and 4·5 in diameter.

Hut Point, Oct. 18 and 25, 1902.

The position of the ligament is somewhat different to that of *Crenella decussata*, Montagu, which is elongate and obliquely internal within the hinder dorsal margin, under the striated hinge-plate. Otherwise the species appear to be conchologically congeneric.

### Limopsis grandis.

(Pl. III., figs. 7–7b.)

Shell large, obliquely ovate, very flat, concentrically striate and very finely radiately striated, white, clothed with a coarse yellowish, hairy periostracum; umbones small, acute, separated by a narrow ligamental area; hinge-plate narrow, slightly sinuate in the middle, with thirteen teeth in a small specimen, and probably about twenty in the adult form; interior of the valves very finely radiately striated, excepting the outer margin, which is smooth and shining; anterior adductor scar small; posterior much larger, elongate pyriform, bounded on the inner side by a thickening of the shell which forms a ridge extending from beneath the umbones beyond the scar almost to the margin of the valve.

Length, 33 millim.; diam., 12.

March 4, 1904, near Antarctic Circle, 254 fathoms.

Closely allied to *L. marionensis*, Smith, but larger and flatter, and also distinguished by the peculiar thickened ridge down the posterior side of the interior of the valves.

Only three dead and worn valves and one young fresh specimen were obtained. *L. læviuscula*, Pelseneer, is also very like the present form.

### Lima (limatula) hodgsoni.

(Pl. III., figs. 8–8b.)

Shell oblong, oblique, narrow above, rather convex, thin, white; anterior side more curved than the posterior; ventral margin arcuate, curving obliquely upwards behind; surface ornamented with 30–35 fine ribs, which are very finely scaled by being crossed by the lines of growth (fig. 8b); the ribs are rather broader than the intervening grooves, and do not occur on the auricles, which are only sculptured with the incremental striæ; the scales are very close-set, and only very little elevated; interior of the valves radiately sulcate, slightly denticulate along the lower margin; umbones central, a little prominent above the ligamental area, which is very narrow diamond-shaped.

Length, 27·5 millim.; height, 35; diam., 20.

Winter Quarters, various dates, 10–130 fathoms, also off Coulman Island, 100 fathoms.

Allied to *Lima pygmæa* Philippi, but much larger, of a rather different form, being broader beneath and much more contracted above. The ribs, also, in the present species are broader and much more beautifully squamate.

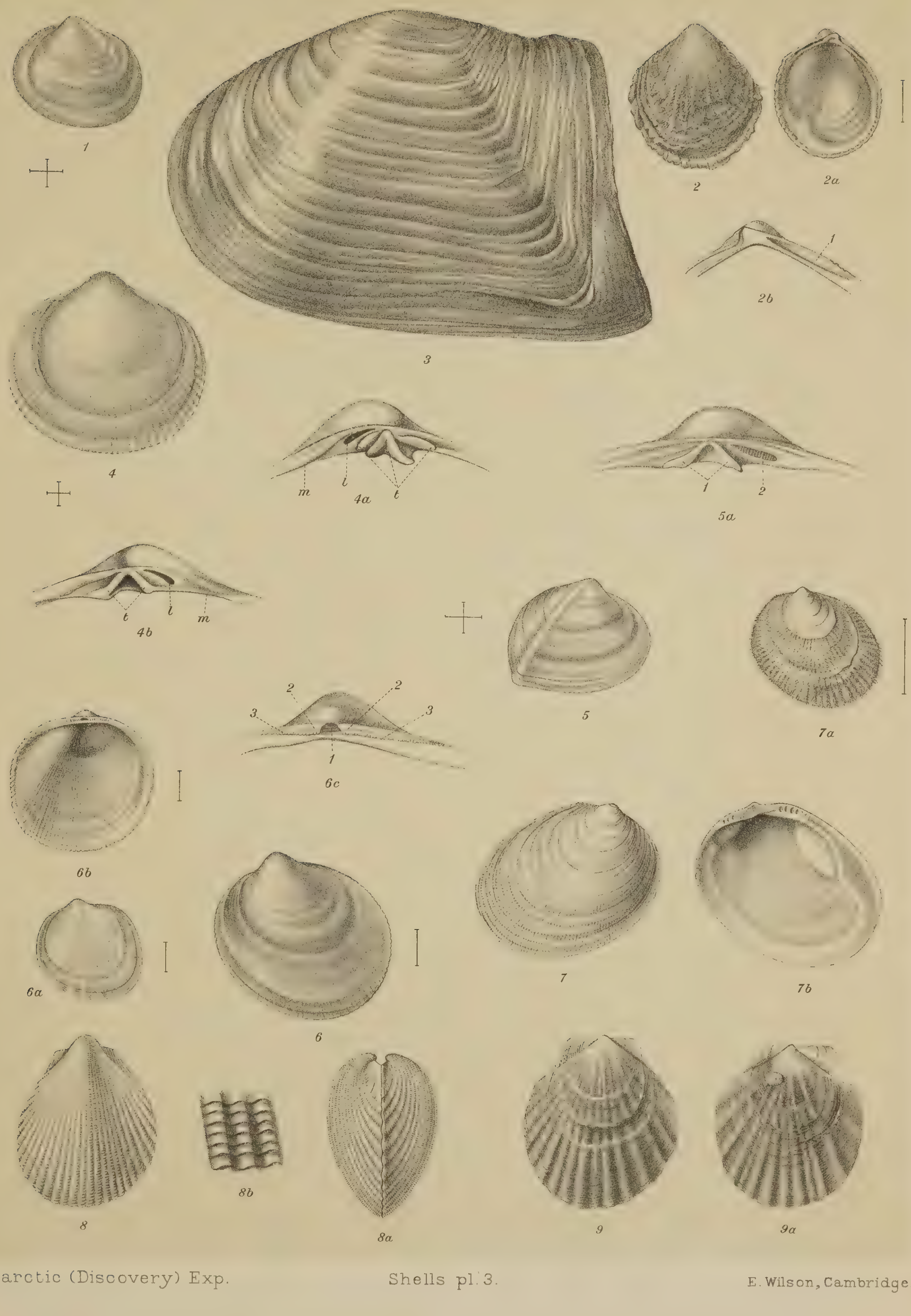
### Pecten colbecki.

(Pl. III., figs. 9–9a.)

*Pecten colbecki*, Smith, Report 'Southern Cross' Mollusca (1902), p. 212, pl. xxv., fig. 11.

Winter Quarters, 20–130 fathoms.

Only three small left valves and one right valve were collected. The former are interesting, as hitherto only the right valve was known. They are all of the same rich purplish red or plum colour as the type, with the ears and umbones whitish. The right is rather flatter than the left valve, and its posterior auricle is a trifle larger than the anterior, but not very deeply sinuated below. Its sculpture is similar to that of the other valves, consisting of about fifteen rounded, but feeble costæ, and very delicate concentric raised striæ. Some of the riblets are broader than others. Owing to the thinness of the shell, the inner surface of both valves in these young specimens is radiately grooved and ridged like the exterior, whereas in the adult, this feature is less observable towards the outer margin, since the costæ become less and less pronounced as the shell increases in size. In the left, and slightly more convex valve, the auricles are almost alike, the anterior being perhaps a trifle the larger.




Antarctic (Discovery) Exp. Shells pl. 3. E. Wilson, Cambridge.

# EXPLANATION OF PLATES.

## PLATE I.

| | |
|---|---|
| Figs. 1–1b. | Thesbia innocens, sp. n. |
| ,, 2, 2a. | Neobuccinum tenerum, sp. n. |
| ,, 3–3d. | Trophon longstaffi, sp. n. |
| ,, 4–4b. | ,, coulmanensis, sp. n. |
| ,, 5, 5a. | Admete delicatula, sp. n. |
| ,, 6, 6a. | Amauropsis rossiana, sp. n. |
| ,, 7–7c. | Trichoconcha mirabilis, g. et sp. n. |
| ,, 8. | Troschelia ? sp. juv. |
| ,, 9, 9a. | Eulima convexa, sp. n. |
| ,, 10–10b. | Scala antarctica, sp. n. |
| ,, 11–11c. | Neoconcha vestita, g. et sp. n. |

## PLATE II.

| | |
|---|---|
| Fig. 1. | Rissoia deserta, sp. n. |
| ,, 2. | ,, adarensis, Smith. |
| ,, 3. | ,, fraudulenta, sp. n. |
| ,, 4. | ,, glacialis, sp. n. |
| ,, 5. | ,, gelida, sp. n. |
| ,, 6, 6a. | Lovenella antarctica, sp. n. |
| ,, 7. | Valvatella refulgens, sp. n. |
| ,, 8. | ,, dulcis, sp. n. |
| ,, 9. | ,, crebrilirulata, sp. n. |
| ,, 10. | ,, minutissima, sp. n. |
| ,, 11, 11a. | Lepeta (Pilidium) antarctica, sp. n. |
| ,, 12. | Bullinella gelida, sp. n. |
| ,, 13–13g. | Chætopleura miranda, sp. n. |
| ,, 14, 14a. | Cuspidaria tenella, sp. n. |
| ,, 15, 15a. | Cardita antarctica, sp. n. |
| ,, 16–16b. | Tellimya antarctica, sp. n. |

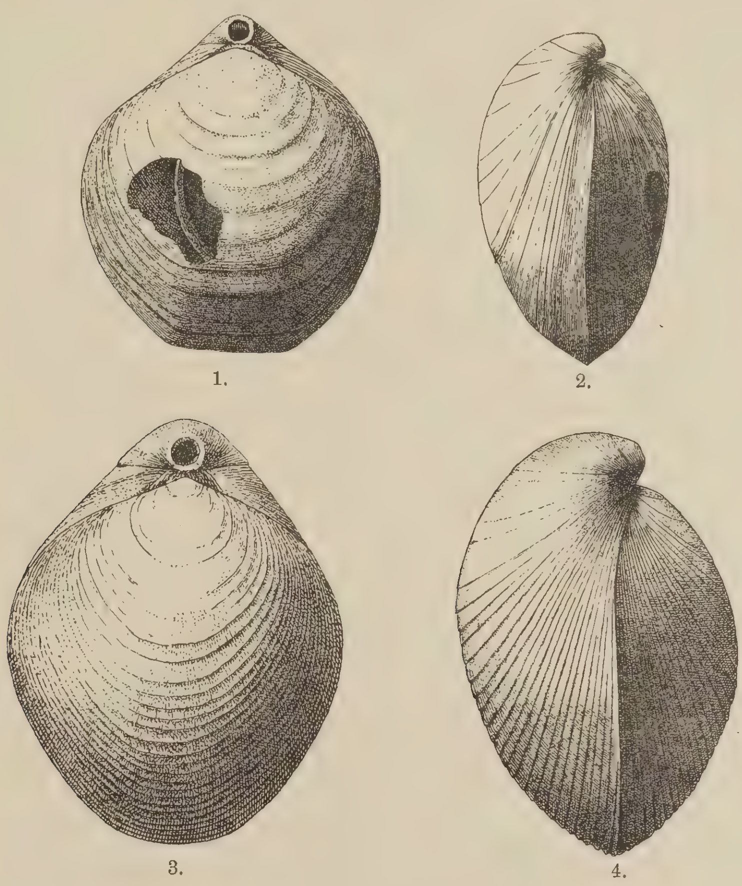
## PLATE III.

| | |
|---|---|
| Fig. 1. | Kellia simulans, sp. n. |
| ,, 2–2b. | Philobrya limoides, sp. n. |
| ,, 3. | Anatina elliptica, King and Broderip. |
| ,, 4–4b. | Cyamium denticulatum, sp. n. |
| ,, 5, 5a. | Diplodonta incerta, sp. n. |
| ,, 6–6c. | Adacnarca nitens, Pelseneer. |
| ,, 7–7b. | Limopsis grandis, sp. n. |
| ,, 8–8b. | Lima (Limatula) hodgsoni, sp. n. |
| ,, 9, 9a. | Pecten colbecki, Smith. |

# BRACHIOPODA.

By Edgar A. Smith, I.S.O.

Only a few specimens of two species of Brachiopoda were obtained by the 'Discovery,' both apparently representing new forms belonging to the genus *Magellania*. One is very distinct from all the known species, on account of its remarkable sculpture, but the other is very closely allied to *M. kerguelenensis* of Davidson, and to the Patagonian *M. venosa* of Solander; indeed, it is with some hesitation that I have ventured to separate it specifically.




Magellania fragilis. (Figs. 1, 2.)

Shell very similar in general aspect to *M. venosa*, from Patagonia,* and *M. kerguelenensis*†, but thinner than either, and with coarser test perforations. *M. venosa*

* See Davidson, Trans. Linn. Soc., 2nd Ser., Vol. IV., Zoology (1881), p. 49.
† Davidson t.c., p. 53.

is more minutely perforated all over, the foramen is smaller, and on each side of it the valve (the ventral) exhibits a more or less distinct keel ; also the internal septum of the dorsal valve is stronger and longer. The present species is perhaps more closely related to *M. kerguelenensis*, but, besides being thinner and more conspicuously perforated, it does not exhibit the mesial depression referred to in the description of that species ; the foramen also is larger. The internal septum is equally thin and delicate. The form is somewhat variable, some specimens being broader than others. The colour is light brown, or dirty horn-colour.

Largest specimen.—Length, 43·5 millim. ; width, 39 ; diam., 24.

Another example.—Length, 37·5 millim. ; width, 29·5 ; diam., 22·5.

Agassiz Island, 300 fathoms, mud, off ice barrier.

A few more or less damaged specimens were obtained.

### Magellania sulcata. (Figs. 3, 4.)

Shell of medium size, ovate, globose, of thin substance, horn-colour, inequivalve, exhibiting, excepting towards the umbones, numerous concentric conspicuous raised lines of growth, producing a remarkable sulcate appearance ; dorsal valve less convex than the ventral, which is produced and curves over so that the foramen, of moderate size and circular, is on a plane with the margin of the valve and separated from the edge by a narrow deltidium ; interior of the valve concentrically sulcate like the exterior ; teeth of ventral valve moderately strong ; loop very thin and delicate, broad and reflexed, with a thin acute septum beneath, extending half-way across the valve, with the crural points long and acute ; perforations of the test large, oblong.

Length, 28 millim. ; width, 23 ; diam., 17.

Coulman Island, 100 fathoms, and Winter Quarters, August 7, 1902, 178 fathoms.

This species is remarkable on account of the concentric sulcations and the coarse perforations of the shell. I do not know of any recent form that exhibits sulci or marked lines of growth of this kind, but among fossil forms a similar kind of surface ornamentation is met with in *Terebratula sulcifera*, Morris, of the lower chalk.

# CRUSTACEA.

## I.—DECAPODA.

By W. T. Calman, D.Sc.

Two species of Decapod Crustacea were obtained by the 'Discovery' within the Antarctic Circle. They have been identified with the two species collected by the German Polar Commission of 1882–1883 at South Georgia. By the courtesy of Dr. Georg Pfeffer, of the Hamburg Museum, who first described the species, I have been able to compare the 'Discovery' specimens with co-types from South Georgia, and to satisfy myself of their identity. With the circumpolar range implied by their occurrence at these two widely separated points, both species combine a remarkable range in depth, for, whereas at South Georgia they were found at 7–9 fathoms, the 'Discovery' dredged both species at depths reaching to 500 fathoms.* Dr. Pfeffer's descriptions, although very detailed and accurate, leave unnoticed certain characters which are now regarded as of systematic importance. I have, therefore, found it necessary to supplement his account on some points. One of the species, *Crangon antarcticus,* has received some attention in recent discussions on the subject of "bipolarity," and I have therefore attempted to define a little more precisely its affinities with related forms.

### FAMILY HIPPOLYTIDÆ.

#### Chorismus antarcticus.

*Hippolyte antarctica* Pfeffer, Jahrb. Hamburg. Wiss. Anst. IV. (1887), p. 51, pl. i. figs. 22–27.

*Description of ovigerous females.*—Total length 87 to 101 mm. Length of carapace (including rostrum) about two-fifths of total length of body. Rostrum equal to or a little longer than the distance from the orbital notch to posterior margin of carapace in the middle line, curved upwards, moderately expanded below; upper margin with eight or nine teeth, of which the second is placed over, or a little in front of, or

* *Crangon antarcticus* was also dredged by the 'Belgica' at a depth of 400–500 fathoms in Lat. 71° S., Long. 88° W.

in one case a very little behind the orbital notch, and the last two are close to the apex of the rostrum; lower margin with six to nine teeth (usually seven.) No supra-orbital teeth, antennal tooth distinct from the lower orbital angle, antero-lateral corner of carapace with a minute (pterygostomial) tooth.

Third abdominal somite with dorsal surface strongly elevated or "humped," but without a definite tubercle as in *Chorismus tuberculatus.* Sixth abdominal somite without movable lateral spines.

Peduncle of antennules reaching to or nearly to two-thirds the length of rostrum, third segment one-half the length of second, spine of first segment ("stylocerite") narrow and acute, reaching to middle or quite to end of second segment; flagella subequal, or inner slightly longer than outer, extending beyond tip of rostrum by one-third to nearly half their length. Antennal scale broad, about equal in length to rostrum, outer edge distinctly and evenly convex, apex broadly rounded, outer spine short.

Mandible with small incisor process and palp of three segments, the first broader than, and as long as the second. Third maxilliped extending nearly to tip of antennal scale, terminal segment twice the length of preceding. Exopod well developed.

First leg extending beyond penultimate segment of third maxilliped, carpus slightly excavate distally, about equal in length to the hand. Second leg extending beyond tip of antennal scale, carpus of eleven, merus of three, and ischium of two segments. Remaining legs moderately stout, fifth leg extending forwards nearly to tip of antennal scale.

Telson not greatly narrowed distally, tip rounded, with seven spines. Inner plate of uropods subequal to the telson and very little shorter than the outer plate, which is broadly rounded at the tip.

The branchial system comprises five pleurobranchiæ on each side on the last five thoracic somites, an arthrobranchia on the third, and a podobranchia on the second maxilliped. There are epipods on the third maxillipeds and on the first two pairs of legs.

*Young males* (55–59 mm. in length) and *females* (42 mm.) Body a little more slender and the rostrum relatively longer, distinctly exceeding the length from orbit to back of carapace. Flagella of antennule little longer than rostrum. Outer edge of antennal scale straight. In two specimens (♂ and ♀) there are twelve segments in carpus of second leg.

The co-typical specimen of *Hippolyte antarctica* used for comparison is an ovigerous female, about 60 mm. in total length. It agrees perfectly with the 'Discovery' specimens except in the following points:—Of the seven teeth on the upper edge of the rostrum only one is close to the point, not two, as in our specimens; the antennal scale is slightly longer than the rostrum, and its outer edge (as in our specimens of similar size) is nearly straight; the third maxillipeds are a

little shorter, and their terminal segment is hardly twice the length of the preceding; the carpus of the first legs is a little shorter than the hand.

*Remarks.*—This species agrees with the type of the genus *Chorismus* (*C. tuberculatus*, Sp. Bate.) in the characters given in my recently published synopsis of the *Hippolytidæ* ('Ann. Mag. Nat. Hist.,' xvii., 1906, p. 30), and further in having no supra-orbital spines, in the mandible-palp being composed of three segments,* the gills seven in number on each side, and the last three pairs of legs without epipods. It differs in having eleven or twelve segments in the carpus of the second legs while *C. tuberculatus* has only nine, in having an exopod on the third maxilliped, and in the fact that the first segment of the mandibular palp is not shorter than the second.

*Occurrences.*—January 22, 1902. 500 fathoms, 1 ♂.
W.Q., February 28, 1902. Less than 20 fathoms, 1 ♂, 1 ♀.
W.Q., January 10, 1903. 130 fathoms, 2 ♀.
W.Q., May 14, 1903. 127 fathoms, 1 ♂, 1 ♀.
W.Q., June 18, 1903. 130 fathoms, 2 ♀.

Fragments of this species were taken from the stomachs of seals on several occasions.

## FAMILY CRANGONIDÆ.

### Crangon † antarcticus.

*C. antarcticus* Pfeffer, Jahrb. Hamburg. Wiss. Anst. iv. (1887), p. 45, pl. i., figs. 1–21; Coutière, C. R. Acad. Sci. Paris, cxxx. (1900), p. 1640; and Bull. Mus. Paris, vi. (1900), p. 240.

*Description of females* (not ovigerous).—Total length, 37·5–77 mm. General form slender. Surface of the carapace very uneven, with strongly marked ridges and hollows; in particular, a more or less sharply defined ridge runs backwards from the median dorsal spine for a distance equal to one-half the length of the carapace. The ridge running backwards from the antennal spine is continuous with that running forwards from the hepatic spine. Rostrum long, slender, compressed and acute, in one case nearly one and a half times as long as the eye-stalks. Abdomen long and slender, sixth somite generally more than one-sixth of total length of body. A pair of slender acute spines on hind margin of fifth somite dorso-laterally. Sixth somite with a strongly-marked double dorsal keel. Telson rounded at the tip, with a median spiniform point. Antennular peduncle slender, the distal end of first segment narrower than one-half the greatest diameter of the eye; outer lobe of first segment nearly flat, broadly ovate, produced anteriorly into a rather feeble spiniform point which does not reach distal

* Spence Bate defines the genus *Chorismus* as having a "biarticulate synaphipod" ('Challenger Rep.' Macrura, p. 616), but he elsewhere correctly states that there are three segments (t.c. pp. 577 and 618).

† Recent reforms in nomenclature having rendered most of the well-known generic names of Crustacea unintelligible without an explanatory footnote, it is necessary to state that I use the name *Crangon* for the genus of which the common shrimp is the type.

end of segment. Antennal scale with outer margin straight, or, in smaller specimens, concave. Third maxillipeds extending to or slightly beyond end of scale. First legs extending a little beyond middle of terminal segment of third maxillipeds; hand from nearly four to nearly five times as long as broad, terminal tooth of palmar edge at about one-fourth of the length of the hand from distal end. Last pair of legs extending forward to the tip of the antennal scale. Endopod of first pleopod articulating with distal inner angle of peduncle.

Branchial system.—Five pleurobranchiæ on each side, on the last five thoracic somites; no arthro- or podo-branchiæ.

*Remarks.*—The 'Discovery' specimens differ from Dr. Pfeffer's description, and from a co-typical specimen with which I have compared them, in the more slender form of the body, due especially to the greater length of the sixth abdominal somite; in the greater length of the rostrum; in the shorter lobe on the basal segment of the antennule, reaching only to about the distal third of the segment, while in the typical form it reaches nearly to the end; and in the narrower "hand" of the first legs. But while each of the three well-preserved specimens in this collection differs from the co-type in all these points, they do so in varying degree. The differences are at least as important as some of those which have been regarded as of specific value by recent writers on the Crangonidæ, but I do not think that they would justify us, at present, in separating the form inhabiting the area explored by the 'Discovery' from that found in the very distant region of South Georgia.

The following table gives some measurements, in millimetres, of the co-type of *C. antarcticus* as compared with the three most perfect specimens in the 'Discovery' collection. All the specimens appear to be females or immature males.

| | Total Length. | Length of Carapace from back of Orbit. | Length of Rostrum from back of Orbit. | Length of Sixth Abdominal Somite. | Length of Telson. | Ratio Length to Breadth of "Hand." |
|---|---|---|---|---|---|---|
| *C. antarcticus*, co-type ... ... | 46·0 | 9·75 | 2·5 | 7·5 | 9·0 | 3·9 |
| 'Discovery,' January 27, 1902 ... | 58·0 | 11·75 | 4·75 | 10·0 | 12·5 | 4·9 |
| „ March 4, 1904 ... ... | 77·0 | 17·0 | — | 13·0 | 15·0 | — |
| „ January 22, 1902 ... | 37·5 | 8·0 | 2·3 | 7·5 | 8·0 | — |

Dr. Pfeffer * was the first to draw attention to the apparent "bipolarity" in the distribution of the genus *Crangon*. With the exception of the very imperfectly known *C. capensis*, Stimpson, from the Cape of Good Hope, *C. antarcticus* is the only species of the genus inhabiting the Southern Hemisphere, and is widely separated from all the other species, which are confined to the temperate and (if *Sclerocrangon* be

* Die niedere Thierwelt des antarctischen Ufergebietes. Internat. Polarf. Deutsch. Exped., ii. (1890), pp. 520–572.

included) the Arctic regions of the Atlantic and Pacific. The question has been discussed by Dr. Ortmann,* who concludes that *C. antarcticus* is specially and closely related to the Californian *C. franciscorum*, Stimpson, and that its presence in the Southern Hemisphere is to be explained by migration from the North along the West coast of America, where the hydrographical conditions are such as to favour an intermixture of northern and southern faunas across the tropic zone.

With a view to testing this conclusion of Dr. Ortmann's, I have carefully compared the specimens of *C. antarcticus* with specimens of *C. franciscorum* in the Museum collection.† The chief character on which Dr. Ortmann relies for linking the two species together is the presence of a pair of dorso-lateral spines on the hind margin of the fifth abdominal somite. This character is conspicuous and definite, but it may be doubted whether it is of great morphological importance. Prof. Sars figures a pair of spines of varying length in nearly the same position in all the larvæ of *Crangonidæ* examined by him,‡ and it seems likely that this larval character may have been retained independently in species not closely related. In other respects *C. franciscorum* differs considerably from the Antarctic species. The surface of the carapace is much less uneven, the various ridges and hollows being much less strongly marked. There is no ridge running backward from the median dorsal spine, and the ridge connecting the antennal and hepatic spines is interrupted by a groove. The pterygostomial spine is not compressed and expanded laterally as it is in *C. antarcticus*. The rostrum is shorter than the eye-stalks, depressed and hollowed on the dorsal surface and bluntly pointed. The sixth abdominal somite is about one-seventh of the total length, and has only a faintly-marked indication of a double keel on its dorsal surface. The telson narrows gradually to an acute tip. The antennular peduncle is stout, the distal end of the first segment broader than three-fourths of the greatest diameter of the eye; the outer lobe of the first segment has its external margin strongly bent upwards, thickened and produced forwards into a strong spine which reaches the distal end of the segment. The outer edge of the antennal scale is slightly convex. Miss Rathbun states (Harriman Alaska Exp., Crustacea, p. 120) that the third maxillipeds do not reach the end of the antennal scale, but in two out of three specimens examined by me they certainly do so. The first legs reach the tip of the third maxillipeds; the palmar edge of the hand is very oblique, its terminal tooth being more than one-third of the length of the hand from the distal end. The last pair of legs reach to about the middle of the antennal scale. The first pleopod differs considerably in shape from that of *C. antarcticus*, the endopod being attached nearly half-way down the inner margin of the peduncle.

* Jenaische Denkschr., VIII. (Semon's Zool. Forschungsreise V.), (1) (1894), p. 77; Proc. Acad. Nat. Sci., Philad., 1895, p. 190; Zool. Jahrb., Syst., IX. (1897), p. 582.

† These specimens, received from the Smithsonian Institute, are labelled as having been collected in California by Stimpson himself, in the course of the North Pacific Exploring Expedition, and may therefore be regarded as co-types.

‡ Bidrag til Kundskaben om Decapodernes Forvandlingar, iii. Fam. Crangonidæ. Arch. Math. Naturvid. xiv. (1890), pp. 132–195, pls. i.–vi.

A difference which may possibly be of greater importance than any of those mentioned above exists, as Prof. Coutière has pointed out, in the branchial system. In addition to the five pleurobranchiæ possessed by *C. antarcticus*, *C. franciscorum* has on each side a well-developed arthrobranchia at the base of the third maxilliped. The statements made by various writers as to the gill-formula of the common shrimp, and of the genus of which it is the type, are curiously conflicting. Although Huxley, in 1878, Boas, in 1880, and Claus, in 1886, gave the number of gills in *C. vulgaris* correctly as six, more recent authors seem to have overlooked the arthrobranchia of the third maxilliped, which, although small, is not at all difficult to see. Sars, in 1890,* gives among the characters distinguishing *Crangon* from *Pontophilus*, the presence of five gills in the former and six in the latter genus, and this statement is copied by Mr. Stebbing.† Ortmann, in his revision of the *Crangonidæ* in 1895,‡ names a number of species of *Crangon* which he has examined and found to have only five gills. One of the names mentioned, "typicus," does not appear elsewhere in the paper, but it may be conjectured that it refers to the typical form of the species *C. vulgaris.* Two other species on the list are *C. affinis* and *C. franciscorum.* In these three species, and also in *C. allmanni* and *C. nigricauda*, I find, on the contrary, that the arthrobranchia is well developed. In the absence of trustworthy data as to the occurrence of this gill in the other species from the northern hemisphere, it is not possible to estimate the importance to be attached to its absence in *C. antarcticus.* It may be noted, however, that it is absent in the characteristically Arctic genus (or subgenus) *Sclerocrangon*, which is otherwise not very sharply defined from *Crangon*, and to which, in its strongly sculptured carapace, the present species has some resemblance. Prof. Coutière, in his preliminary notes on the Decapoda of the 'Belgica,' has called attention to this resemblance to *Sclerocrangon*; but he suggests, with some hesitation, the establishment of a new subgenus, *Notocrangon*, for the Antarctic species. I have not been able to examine the structure of the male pleopods, to which he attaches some importance, but the other characters which he mentions do not seem to me to justify this step.

*Larvæ.*—A number of larvæ of this species were collected, all in a stage of development corresponding to the "last larval stage" of Prof. Sars. The rostrum is very long and slender, extending well beyond the eyes. There is a small median dorsal tooth on the carapace, about midway between the back of the orbit and the "cervical" groove, and a little in front of it is a rounded papilla (represented in some of Sars's figures) probably representing the problematical "dorsal organ" of some Euphausid larvæ. The abdomen is unarmed, except for the paired spines at the posterior end of the fifth somite, which are long and slender, almost as in Sars's figures of the larvæ of *Pontophilus*, and, as in that genus also, the sixth somite is very long. The telson is very large, in the form of an almost equilateral triangle, with the posterior margin

* Arch. Math. Naturvid, xiv. (1890), p. 153. † Hist. Crustacea (1893), p. 227. ‡ Proc. Acad. Nat. Sci., Philad. (1895), p. 175.

concave, but not deeply notched. All the appendages are present. The first legs are subchelate. The second legs are (as in the other species of the genus *Crangon*) devoid of exopods. The pleopods are large but uniramous. There are only four gills on each side, corresponding to the first four legs.

*Occurrences.*—January 13, 1902. 100 fathoms, off Coulman Island, 1 ♀.
January 22, 1902. 500 fathoms, 1 ♂ (juv.) (?).
January 27, 1902. 300 fathoms, off Barrier, 1 ♀.
March 4, 1904. 254 fathoms, 1 ♀.

Larvæ of this species were taken in Winter Quarters on September 13, 1902, February 8, 1903, March 10, 1903, and March 23, 1903.

Fragments were taken from the stomachs of seals on several occasions.

# CRUSTACEA.

## II.—CUMACEA.

By W. T. Calman, D.Sc.

(1 Plate.)

The collection of *Cumacea* obtained by the 'Discovery' is a very small one. In addition to a species collected at the Auckland Islands and omitted from the present report as not belonging to the strictly Antarctic fauna, it comprises only four species, two of which are represented by solitary specimens.

No *Cumacea* have hitherto been recorded from within the Antarctic Circle. In the sub-Antarctic region five species were got by the 'Challenger' at Kerguelen and described by Prof. Sars, and Dr. Zimmer has more recently described two species from South Georgia and four from Tierra del Fuego. I am unable to identify any of these species in the present collection.

On the other hand, I have regarded one of the forms got by the 'Discovery' as a variety of a species known hitherto from the North Atlantic and the Mediterranean. It is necessary to add, however, that I do not think much importance can be attached to this circumstance from the point of view of zoo-geography. In this connection I would refer to the emphatic statement of Dr. Giesbrecht, already quoted with approval by Dr. H. J. Hansen :—"Unsere Kenntnisse von der Microfauna der Küsten aussereuropaischen Meere sind kaum der Rede werth." My own work leads me to believe that the *Cumacea* will, in the future, illustrate most admirably the opinion of these two distinguished carcinologists. The species in question, *Campylaspis verrucosa*, was described by Prof. Sars in 1863, and, until 1901, it was only known from Norwegian seas. More recently it has been obtained by Mr. E. W. L. Holt off the West of Ireland, and by Dr. Lo Bianco in the Mediterranean, near Capri. There can be little doubt that, with appropriate methods of collecting, its known range might be vastly increased, and it might even be found to be continuous with that of the variety now described.

### Leucon australis.

(Text-figs. 1–3.)

*Description of Ovigerous female.*—Total length, 3·5 mm. Carapace about two-sevenths of total length, compressed, the dorsal crest closely serrated throughout its whole length. Pseudorostrum horizontal or very slightly upturned, acute, a little less than one-fourth of total length of carapace. Antennal notch widely open, occupying the whole of antero-lateral margin. Antero-lateral angle prominent, triangular,

serrated on its lower edge. Antennules with the inner ramus of considerable size, longer than the first segment of outer ramus. Uropods a little longer than the last two somites together, peduncle shorter than the subequal rami and having five spines on its inner edge. Endopod with ten spines on its inner edge, without setæ on its outer edge, the proximal segment twice the length of the distal.

FIG. 1.—*Leucon australis*, ADULT FEMALE, FROM THE SIDE, APPENDAGES OMITTED.

*Occurrence.*—W.Q., June 15, 1902. D-net.

*Remarks.*—Among the thirteen species at present referred to the genus *Leucon*, four have the inner ramus of the antennule of considerable size, at least equal in length to the first segment of the outer. Of these, *L. longirostris*, Sars, *L. tenuirostris*, Sars, and *L. siphonatus*, Calman, have the antennal notch narrow and the

FIG. 2.—*Leucon australis*, CARAPACE AND ANTENNULE.

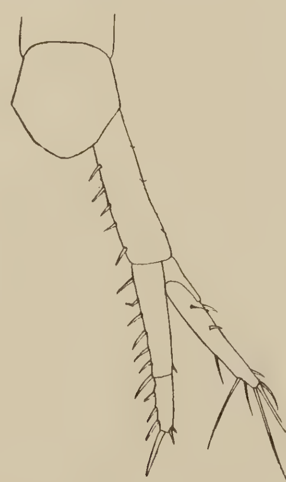


FIG. 3.—*Leucon australis*, LAST SOMITE AND UROPOD.

antero-lateral margin serrated above the notch. *L. septemdentatus*, Zimmer, from Tierra del Fuego, resembles the present species in the form of the antennal notch, but differs in the truncate pseudorostrum, in having the serrations of the dorsal crest confined to its anterior part, and the distal segment of the inner ramus of the uropods much less than half the length of the proximal segment.

## Eudorella similis.

(Figs. 1–6 on Plate.)

*Description of sub-adult female.*—Total length 5·8 mm. The antero-lateral margin (fig. 2) of the carapace ends below in a strong curved tooth, above which the margin is concave, becoming convex and bearing about four very slightly marked teeth immediately below the well-defined antennal notch. Above the notch the margin is nearly straight, and is without teeth. The upper margin of the pseudorostrum is convex, without any projection behind, and bears a tuft of long setæ.

The penultimate abdominal somite bears on its posterior margin above a pair of very long setæ.

The antennules (figs. 3 and 3a) have both rami rather stouter than is usual in the genus and armed with strong spines.

The maxillipeds and legs agree very closely in their proportions and armature with those of *E. truncatula* as figured by Sars.

The uropods (fig. 6) show no conspicuous difference from those of *E. truncatula*, except that the rami are somewhat stouter.

*Adult male.*—Total length, 6 mm. The anterior margin of the carapace (fig. 4) is strongly convex, projecting well in front of the single small tooth which defines it below.

In the outer ramus of the antennule (fig. 5) the proximal segment is equal to the other three together. The inner ramus reaches to the end of the second segment of the outer.

*Occurrences.*—W.Q., June 15, 1902. D-net. Many specimens. 'Coulman Island, 100 fathoms,' 1 specimen.

*Remarks.*—Among the eight species of this genus which have been described from northern seas (North Atlantic and Mediterranean), *E. emarginata* (Kröyer) stands somewhat apart, having no distinct antennal notch in the carapace of the female. Of the remainder, only *E. hispida* and *E. nana*, G. O. Sars, agree with the present species in having a strong tooth at the antero-lateral angle of the carapace. In both of these species, however, the antero-lateral margin has strong teeth above as well as below the antennal notch in the female. The only species of *Eudorella* hitherto recorded from the Southern Hemisphere is *E. splendida*, Zimmer, from South Georgia. The figure of this species is not entirely satisfactory, but it suggests that the form of the antero-lateral margin of the carapace is very similar to that of the present species. The specimens examined by me might, in fact, have been identified with Dr. Zimmer's species, were it not that the latter has the upper edge of the pseudorostrum produced behind into a strong curved tooth, of which no trace is to be seen in the 'Discovery' specimens.

## Cumella australis.

(Figs. 7–13 on Plate.)

*Description of adult female.*—Total length, 2·9 mm. Carapace large, about four-ninths of the total length, compressed, its greatest width little more than half its length. Seen from the side, its vertical height is about two-thirds of its length; the dorsal edge is strongly arched and serrated throughout its length. There are about twenty large teeth, with some smaller teeth between and beside them, especially in the posterior part. The anterior tooth of the dorsal crest is elevated above, and overhangs the ocular lobe, which is sub-globular and prominent. The pseudorostrum is short, vertically truncate and slightly oblique, the pseudorostral plates meeting in front of the ocular lobe for a distance equal to about half the diameter of the latter. As seen from the side, the fronto-lateral suture has a strong sigmoid curve; the antennal notch is wide and semi-circular; the antero-lateral angle is rounded and strongly serrated. The third of the free thoracic somites is produced dorsally into a pair of stout teeth, closely approximated in the middle line, curved upwards as seen from the side, and overhanging the following somite. The abdomen is a little shorter than the cephalothoracic region, the somites stout and cylindrical. The third maxillipeds resemble those of *C. pygmæa*, but the basipodite has about four teeth, the distal one very strong, on its inner margin. The meropodite also bears a stout tooth internally, and the carpopodite has a smaller one at the distal end of its inner edge. The first legs (fig. 9) are rather short and stout, about three-quarters the length of the carapace; the basipodite is about two-thirds the length of the remaining segments, with five strong teeth on the distal part of its outer edge, and one on its inner edge. The second legs (fig. 10) are very similar in proportions and armature to those of *C. pygmæa.* The third legs (fig. 11) have the basipodite slender and curved, longer by one quarter than the remaining segments together. The carpopodite is nearly twice the length of the meropodite, and $1\frac{1}{2}$ times as long as the propodite. The fourth legs (fig. 12) are similar to the third, but the fifth are much shorter. The basipodite is about two-thirds the length of the remaining segments. The uropods (fig. 13) have the peduncle a little less than twice the length of the last somite. The inner edge is serrated, beginning at about one-third of its length from the base, the serrations diminishing in size distally. The endopodite is about two-thirds the length of the peduncle, and carries a terminal spine of half its length. Its inner edge is serrated, and bears two (perhaps three) short spines. The exopodite is two-thirds the length of the endopodite, and has a long and slender terminal spine.

*Occurrence*:—'W.Q., May 26, 1903.' 1 specimen.

*Remarks*:—This species appears to be sufficiently distinguished from the three known species of *Cumella* by the larger carapace, with its strongly arched dorsal

edge, the numerous serrations of the dorsal crest, and the double tooth-like projection of the third free somite.

## Campylaspis verrucosa var. antarctica.

(Figs. 14–16 on Plate, and text-fig. 4.)

*C. verrucosa*, G. O. Sars, Nyt Mag. Naturvid. xv., p. 105 (1868); id., Crust. Norway, III., p. 90, pl. lxiii. (1900); Calman, Cumacea, Fisheries, Ireland, Sci. Invest. 1904, I. (1905), p. 35; id., Mitth. Zool. Stat. Neapel, xvii. (1906), p. 424.

The Antarctic specimens which I refer to this species differ in the following points from all the northern specimens with which I have compared them:—

The hairs scattered over the surface of the body are much longer and more conspicuous, though not, apparently, more numerous. The sides of the carapace are

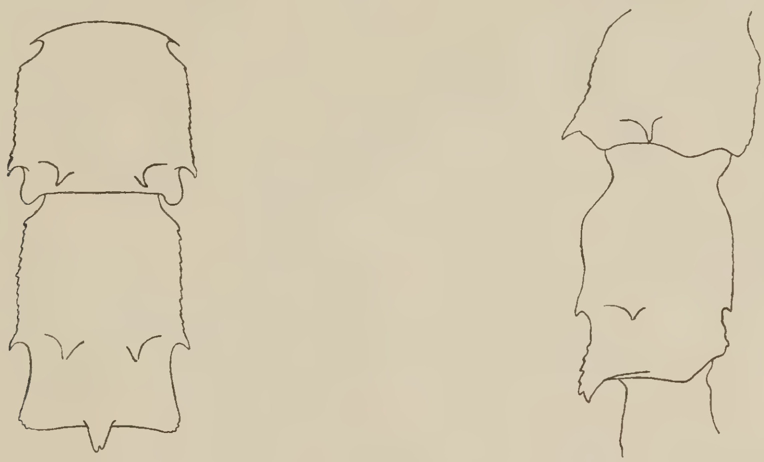


Fig. 4.—*Campylaspis verrucosa*, var. *antarctica*, fourth and fifth somites of abdomen, from above and from the side.

more distinctly flattened or even slightly hollowed, especially over an oblique area, defined above and below by rows of tubercles, and corresponding apparently to the lateral groove of *C. sulcata*. The dorsal tubercles of the first five abdominal somites are replaced by sharp teeth (Text-fig. 4), pointing backwards, and having the edges more or less distinctly serrated; and they are accompanied on each somite by a pair of dorso-lateral teeth, which are hardly indicated in the northern specimens. The constriction of the fifth somite (Text-fig. 4) is much more strongly marked, and the posterior margin of the somite is produced, on the dorsal side, into a curved median tooth, serrated on the upper margin, in place of a small tubercle in the northern specimens. The thoracic limbs do not differ perceptibly in the form, relative proportions or armature of the various segments. The uropods (fig. 16) have the peduncle much more strongly serrated, and the teeth on the inner margin are spiniform, curved and irregular in size. The inner edge of the endopod is also more distinctly serrated. The specimens are larger than any others I have seen. Adult females measure 5·35 mm. in length of body.

For the purpose of comparison, I have examined a series of specimens of *C. verrucosa* from the West of Ireland and from the Mediterranean; those from the latter locality include some determined by Prof. Sars himself. These specimens, as I have elsewhere noted, show considerable variation among themselves and differ in some points from Prof. Sars's figures and description. In view of this variation, it does not seem possible to attribute specific value to the characters which distinguish the Antarctic from the northern specimens, more especially since I have only very few fully adult specimens of the latter.

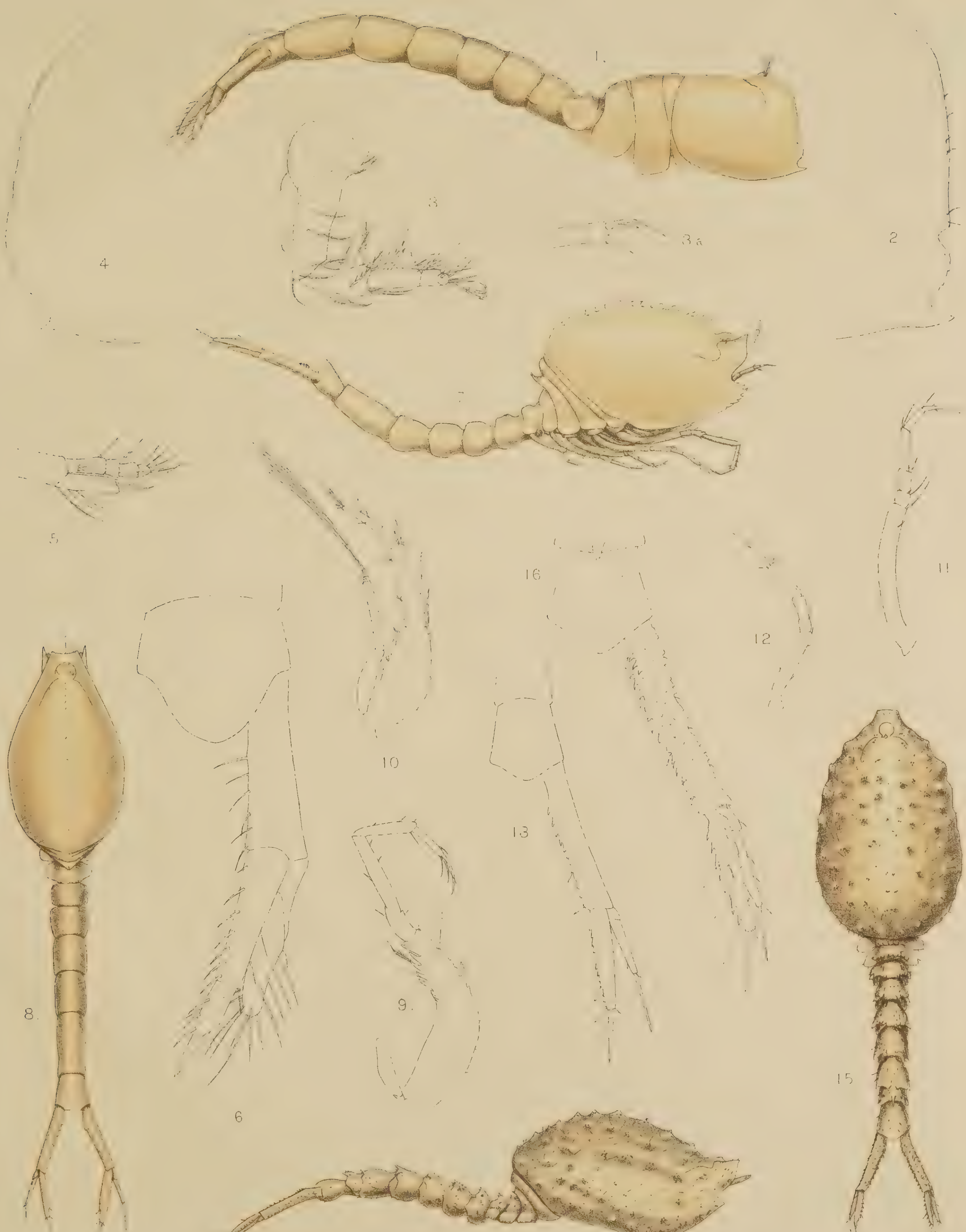
*Campylaspis nodulosa,* described by Prof. Sars from specimens obtained by the 'Challenger' at Kerguelen, is very similar to the present species, but the type specimens, although of large size (3·75 mm. in length according to my measurements *), are without any trace of the last pair of legs, and may, therefore, be presumed to be immature. The smallest specimens of *C. verrucosa* which I have seen are about 2·5 mm. long, and have the last legs already fully developed. The smallest of the 'Discovery' specimens are about the same size as the types of *C. nodulosa,* and they agree in all essentials with the adults. It is likely, therefore, that before attaining the adult state the Kerguelen form must grow to a size greatly exceeding that of the 'Discovery' specimens, and it will be necessary to wait until adult specimens are obtained before deciding what value is to be attached to the characters distinguishing it. The most important of these characters are the smaller relative size of the carapace, which is less than one-half of the length of the body, and the absence of any tubercles or teeth on the dorsal surface of the abdominal somites.

*Occurrence*:—'W.Q., Aug. 29, 1903, Sept. 8, 1903, and Feb. 13, 1904.' Many specimens.

## Explanation of the Plate.

Fig. 1. *Eudorella similis*, sub-adult female, from the side, appendages omitted.
„ 2. „ „ front margin of carapace.
„ 3. „ „ antennule, 3a, inner ramus of same.
„ 4. „ adult male, front margin of carapace.
„ 5. „ „ terminal part of antennule.
„ 6. „ sub-adult female, last somite and uropod.
„ 7. *Cumella australis*, adult female, from the side.
„ 8. „ „ from above.
„ 9. „ „ first leg.
„ 10. „ „ second leg.
„ 11. „ „ third leg.
„ 12. „ „ fifth leg.
„ 13. „ „ last somite and uropod.
„ 14. *Campylaspis verrucosa*, var. *antarctica*, adult female, from the side, appendages omitted.
„ 15. „ „ „ from above.
„ 16. „ „ „ last somite and uropod.

* Sars says "Nearly 5 mm.," which is a little too much, even if the uropods be included.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